THE

ENGINEERING MAGAZINE

VOL. XV. AUGUST, 1898. No. 5.

THE NAVIES AND NAVAL CONSTRUCTION PROGRAMME OF 1898.

PRESENT TENDENCIES IN DESIGN, ARMAMENT, AND MARINE ENGINEERING.

By H. W. Wilson.

IN the closing decade of the nineteenth century the world is witnessing a remarkable struggle for sea power. The old navies have been reconstructed and immensely increased. New navies of the most formidable proportions have been created. In the case of England the era of naval development opened in 1885, following upon the vigorous propaganda of the *Pall Mall Gazette* under Mr. Stead. In the case of Russia and France the period of great increase began in 1890; in the case of Germany, in 1888. Japan discovered the immense value of a navy to herself in the war of 1894–5, since which she has embarked upon an enormous programme. The strength of the naval movement generally throughout the world could not be better illustrated than by the fact that in the ten years, 1878–1887, the seven chief naval powers launched 49 battleships, while in the ten years, 1888–1897, these powers launched 79. The seven powers had only 7 battleships on the stocks at the close of the year 1887; they had 25 at the close of 1897.

In the present year there has been a further and remarkable development, due mainly, in my judgment, to the feeling that a great struggle for the trade of China is near at hand. Thus Germany has adopted a fixed programme of ship-building, to be completed in six years, at a cost of about £20,500,000,—a scheme rivalling in its magnitude the British naval defence act. Under this the vessels to be built are as follows:

	New.	Replacing obsolete ships.	Total.
Battleships	7	5	12
Large cruisers	2	0	2
Small cruisers	7	12	19
	16	17	33

besides minor craft. By the British naval defence act only ten battle-

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ships were provided. One most important feature of the present German sextennate is that it provides for the automatic replacement of old ships. The German admiralty holds that a battleship becomes obsolete and ineffective in twenty-five years from her launch, and must then be replaced.

In 1897 France, in great alarm, real or affected, at her naval position, adopted a supplementary programme. Her new construction vote for 1898 shows a very substantial increase (about £1,000,000) on 1897. Her new ships laid down in 1897–8 were as follows:

	1897.	1898.	Total.
Battleships	1	1	2
Armoured cruisers, large	3	3	6
" " small	1	2	3
Destroyers	7	0	7
Torpedo boats	24	11	35

Her example was followed by Russia, which, in March, 1898, suddenly appropriated a sum of 90,000,000 roubles (about £9,000,000) for an extraordinary naval programme, to be spread over seven years. Subsequent information, from a source which I am not at liberty to disclose, but which is trustworthy, leads to the conclusion that a very much larger sum is to be spent, and the spending to be spread over a very much shorter time. The ships to be laid down in Russia in 1898, excluding those which have figured in previous programmes, are these:

	Baltic.	Black Sea.	Total.
Battleships	5	—	5
Armoured cruisers	—	1	1
Cruisers	2	2	4
Destroyers	28	—	28

But against the above must be set the fact that one battleship of the Sissoi class and one of the Apraxixe class appear to have been dropped. Still, the net gain is considerable, and two large battleships for the Black sea fleet, projected since the beginning of 1897, are now either in hand or to be commenced at once. Of the five Baltic battleships three will be built in Russia and two abroad. The order for one has already been given to Messrs. Cramp, of Philadelphia, who are to deliver the ship in thirty months. The order for a second is likely to go to San Francisco.

In England there have been no very special efforts to meet these enormous programmes, and it is certain that, unless steps are very quickly taken, the preponderance of that country will be lost.*

* The day after this was written Mr. Goschen, first lord of the admiralty, promised a supplementary vote.

Her extraordinary programme for 1897 and her ordinary programme for 1898 were as follows:

Battleships	3
Large armoured cruisers	8
Destroyers	4

And in 1898, for the first time since 1894, her contemplated expenditure on new construction falls below that of France and Russia.* The danger is aggravated by the fact that, though her contemplated expenditure for 1897 was £7,191,000, owing to the dispute in the engineering trade only £4,920,000—or less by £480,000 than the sums spent by France and Russia—was actually expended in that year. Thus she has lost ground, and is still losing.

Far otherwise has been the action of Japan. Recognising that the safety and future of an island State must depend upon its navy, the Japanese government, supported by the Japanese nation, is pushing forward its programme of new construction with the utmost activity. The following new ships appear to have been laid down by Japan, or to be projected for 1898:

Battleship	1
Armoured cruisers	3
Destroyers	8
Torpedo boats	12

In the United States, where the war with Spain has shown the importance of a great navy, a large programme for 1898 is in hand:

Battleships	3
Monitors	4
Destroyers	16
Torpedo boats	12

Such are the great naval powers' programmes for 1898. It is perfectly plain that great efforts are being made on the continent to overcome England and Japan, and these efforts will be furthered by the drop in the military expenditure of the continental States, and by the increasing necessity of a larger army which England realizes.

The exact naval position of England in relation to France and Russia is difficult to determine. The difficulty arises in the classifications of ships. But by far the best tables as yet placed before the public are those of Lord Charles Beresford, which are framed on a trustworthy principle. One or two alterations have been made to bring them up to date, and Germany and the United States have been included.

* England, new construction vote, £7,638,000.
France, £4,000,000.
Russia, £3,280,000 + the extraordinary appropriation for the year, which cannot be less than £1,000,000, and is probably much more.

Battleships.

Class A. Seaworthy; heavy battery; speed, 16 knots or more; Q. F. armament; displacement of 9,000 tons and more; ten years old or less.

Gt. Britain.	France.	Russia.	Germany.	U. S, A.
3 Projected.‡	3 Jénas.§	7 Peresviets.	5 Kaiser Friedrich III.§	3 Indianas.
3 Formidables.§	3 Charlemagnes.	3 Three Saints.	4 Brandenb'gs.	1 Iowa.
6 Canopuses.	1 Henri IV.*	3 Poltavas.		2 Kearsarge.
9 Majestics	4 Carnots	2 Sissoi Veli'is†		3 Alabamas.
1 Renown.	1 Jauréguiberry.	1 Geo. Victors		3 New.‡
8 R. Sovereigns.	1 Brennus.			
2 Niles.		1 Navarin.‡		
2 Centurions.				
34	13	17	9	12

* 9,000 tons.
† Trial displacement, 9,470 tons.
‡ Not yet laid down.
§ Two of these not yet laid down.
‖ Five of these not yet laid down.

Class B 1. Modern battleships; ten years old or less, of small size; inferior in radius of action and seaworthiness, but well-protected and heavily armed.

Gt. Britain.	France.	Russia.	Germany.	U. S. A.
0	4 Valmys.	1 XII Apostles	8 Siegfrieds.	1 Texas.
		3 Oushakovs.		10 Monitors.
0	4	4	8	11

Class B 2. Battleships more than 10 years old, and not so good in armour or armament.

Gt. Britain.	France.	Russia,	Germany.	U. S. A.
1 Sanspareil.	3 Magentas,	3 Sinopes.	0	0
6 Admirals.	1 Hoche.	2 Alexander II.'s.		
2 Colossuses.	2 Formidables.*			
2 Conquerors.	1 Duperré.			
	2 Devastations.*			
	4 Caimans.*			
11	13	5	0	0

* Rearmed (in part) or refitted.

Class C. Old battle-ships, rearmed and refitted.

Gt. Britain.	France.	Russia.	Germany.	U. S. A.
2 Devastations.	1 Redoubtable.	0	4 Badens.	0
2 Ruperts.	1 Furieux.		1 Oldenburg.	
3*	2	0	5	0

* Bellerephon omitted, as she was rearmed more than 10 years ago and is 33 years old.

Summary of Effective Line of Battle Ships,

	Britain.	France.	Russia.	Germany.	U. S. A.
Class A	34	13	17	9	12
B1	0	4	4	8	7 to 11
B2	11	13	5	0	0
C	3	2	0	5	0
	48	32	29	22	23

Besides these, England has the old muzzle-loading ships, which have been re-boilered or re-engined recently—Alexandra (4 breech-loaders), Sultan, Monarch, Hercules, Temeraire, and Dreadnought. All these ships are now of great age, but they are good sea-keepers.

Armoured Cruisers.

Class A. Speed 20 knots and more; protection on the water-line add to guns.

Gt. Britain.	France.	Russia.	Germany.	U. S. A.
8 Cressys.	6 Montcalms.	1 Gromoboi.	1 Bismarck.	1 Brooklyn.
	3 Dupleixs.	1 Projected.	2 Projected.	1 New York.
	1 Jeanne d'Arc.			
	1 Dupuy de Lôme.			
8	11	2	3	2

Class B. Speed 18 knots and more; water-line protected.

7 Auroras.	1 Pothnau.	1 Rossiya.	0	0
	4 Bruixs.	11 Rurick.		
7	5	2	0	0

Class C. Speed under 18 knots.

2 Warspites.	2 Vaubans.	1 Nacchimor.	0	0
		1 Vlad. Monomakh.		
		1 Pam. Azova.		
		1 Dm. Donskoi.		
2	2	4	0	0

Summary of Armoured Cruisers.

	Gt. Britain.	France.	Russia.	Germany.	U. S. A.
Class A	8	11	2	3	2
B	7	5	2	0	0
C	2	2	4	0	0
	17	18	8	3	2

Protected Cruisers.

	G. B.	France.	Russia.	Germany.	U. S, A.
A. Speed more than 22 knots for commerce destroyers	0	3	0	0	2
B. Large sea-going cruisers, protected gun-positions (case-mates or turrets.)	10	1	0	5	0
C. Large sea-going cruisers, but not protected on all gun-positions	11	1	0	1	1
D. Medium cruisers	32	7	6	3	6
E. Scouts (17 knots and more)	32	21	2	3	5
	105	33	8	12	14

Torpedo Flotilla.

Torpedo gunboats	33	21	9	4	1
Destroyers	96	7	29	9	20
Large torpedo boats (under 10 years, displacement 100 tons or over)	16	137	32	32	16
	145	165	70	45	37

Harbour Defence Flotilla.

England, France, and Russia all have numerous old ironclads, small turret ships for harbour defence, and antiquated and small torpedo boats, which can render good service in this direction.

From this table it appears that England is superior to France and Russia in battleships of the largest size, inferior in small modern battleships, much inferior in middle-aged battleships, inferior in the best class of armoured cruisers, greatly superior in protected cruisers, and much inferior in the number of her torpedo craft. At all these points, however, there are compensating features, which it would be unjust to overlook. Her large battleships are generally uniform in type. There is little difference in size, design, armament, and protection between the first thirty ships in her total of class A. A similar uniformity does not exist in the French or Russian ships, though unquestionably Russia is seeking to obtain it. The numerical predominance of France and Russia depends upon classes B 1 and B 2, and the ships of B 1 are generally small, indifferent sea-boats, heavy rollers, and not to be compared in speed or endurance with the Majestic or Royal Sovereign.

Turning now from the comparative strength of the powers to the types which are being built, we notice some striking facts. The tendency everywhere appears to be to build large battleships. Russia seems to have dropped a Sissoi and a ship of the Apraxixe class, both vessels of comparatively small size, which were stated to be projected in 1897. France has discontinued the construction of coast-defence ships, for the Henri IV, which is a glorified Valmy, a legacy of 1895, and, moreover, a very great advance upon the Valmy in nautical qualities. England, after her construction of the two Centurions,—extremely weak ships for their size in the matter of armament,—has gone back to large dimensions, and her latest battleships range between 12,900 and 15,000 tons. Japan has advanced from 12,450 tons to about 15,000 tons. The United States alone have been able to get satisfactory results on a comparatively low displacement, their battleships ranging from 10,200 tons in the Indiana to 11,500 in the Alabama, nor have these results involved, in their case, a sacrifice of nautical qualities. The Indiana class, before receiving bilge-keels, were heavy rollers, and in any case are not good fighters in a seaway. But they have stood the test of war well, and most of their defects are remedied in the Alabamas, which have a high freeboard forward. The United States still cling to the coast-defence ship in its worst form, for their navy department has just decided to lay down four small monitors, regardless of their disadvantages as to speed, coal capacity, and unsteadiness.

The growing sense of the immense value of speed and seaworthiness is leading everywhere to a great increase in the class of armoured cruisers. In some of the latest British and German designs the battleships and armoured cruisers shade off into each other, and it is hard to say where the one class begins and the other ends. Generally the distinction is that the battleship carries four armour-piercing guns and the cruisers only two, while the cruiser has an advantage in speed of two to three knots.

The French armoured cruisers, to be constructed under the new French programme, seem a better compromise than the Cressy, on their smaller displacement, and are very formidable ships. They have a narrow end-to-end steel belt, 6 inches thick amidships at the upper level, tapering down to 2.4 inches at each end and apparently at the lower level. Above this belt they have a stroke of 3.8-inch plating. Their battery is weaker than the Cressy's,—two 7.6 inch, eight 6.3-inch, four 3.9-inch, and twenty-two small guns, with two torpedo tubes. The heavier weapons are in 6-inch casemates, or turrets, and a rapid supply of ammunition—a very important point—is secured by fourteen electric hoists. In this direction, it is to be feared, very many of the newest English ships are imperfect, and it was noted in the Channel Squadron, during recent target practice under battle conditions, that to maintain the supply of ammunition to the quick-firers was exceedingly difficult. The engine-power of the six cruisers varies between 19,600 and 20,000 h. p., but this appears to be with forced draught. One of the six, moreover, carries six Temple boilers, which are of a particularly frail type, better suited to torpedo vessels than to large cruisers. These ships have three screws—an advantage over the Cressy's two, as there is greater security against disablement, less power to be transmitted by each shaft, and less force to be developed by each engine. Against this must be set greater complication, and not quite so satisfactory results for the same power as in the twin-screw system. The French cruisers are to be fitted to use liquid fuel.

The recurrence to a large surface of moderate armour, which is so marked in the new cruiser, is as plain in the battleship. If we take the American types, this movement is most distinctly seen. First comes the Indiana, virtually a Royal Sovereign, but with a low freeboard and with all her heavy guns behind stout armour. In the Iowa the armour belt diminishes in thickness, but is longer, and the space above it covered by moderate armour is greater. In the Kearsarge and Kentucky (singularly misleading illustrations of which and of the Iowa appear in the usually faultless Brassey) the unarmoured target is very small indeed, and the whole centre of the ship is thoroughly pro-

tected against anything under the finest 6-inch A. P. shot, striking squarely at close quarters. In these ships a 4-inch belt is carried forward to the ram, to protect the bows from injury by small Q. F. projectiles, with the consequences of submersion of the ship's head and emergence of her screws and rudder. This is a wise precaution, and England has adopted it by placing 2-inch nickel steel upon the stems of her Canopus, Cressy, and Arrogant classes. The British 2-inch plating is carried higher up than the American 4-inch; so, though there is a difference in thickness, the weight employed is about the same.

The Alabama class is similar in protective qualities to the Kearsarge. The weight of armour carried by these ships, exclusive of the horizontal deck, is about 2,000 tons, which is considerably in excess of the Canopus-class armour. But against this the British ships have the advantage in speed, habitability, and seaworthiness. In ammunition-supply the British ships have little advantage. They carry more rounds for each of the heavy guns, though the American allowance of fifty per gun is probably ample; but in the supply for the 6-in. Q.F. there is no difference. The tendency to simplify the battery asserts itself in the Alabama class. The 8-inch, an intermediate calibre, has vanished. Even in French ships, which are often, as the *Marine Française* puts it, "veritables museums," this tendency appears. To the author it seems that four calibres will give every type of gun required—12-inch for the attack of armour, 6-in for the destruction of thinly-armoured or unarmoured works, 6 or 12 pounders for the destruction of torpedo craft, and 1 pounders for the tops.

Of the Russian Peresviet type too little is known to enable us to form any clear idea of their protective qualities. They appear to be similar in type to the British Canopus, but are slower. They are also much weaker in their heavy battery. Their coal-supply (2,035 tons) is very large, and shows that Russia has grasped the immense influence which coal-supply will exert in war.

The French type of battleship has many peculiar features, some of which are admirable. In their newest vessels these are the most striking points: high speed; extraordinarily effective protection on the waterline, obtained by an end-to-end belt of thick armour, with two armour decks, one at the upper level of the belt, the other at the lower, and a complete belt of thin armour above the thick belt, rising at the bows to a considerable height; two heavily-protected gun-positions, electrically manœuvred; feebly-protected auxiliary battery; excellent arrangement for ammunition-supply. To British eyes their great defect is the gap of absolutely unarmoured side, intervening

between the belt and the auxiliary battery. This invites high-explosive and common shell, and it looks as though the upper part of the ship might be put out of action without the submerged hull being injured. In that case the complete belt and double deck would simply save the hull for the captor.

In the smaller classes small protected cruisers appear to he going out of fashion, except in England, and even her Pelorus class is not a very useful type. Its ships are relatively slow and very badly armed. Cruisers of 4,000 to 6,000 tons are still in favour everywhere, and Germany has obtained very fine results with such vessels. Elswick has produced incomparably the best and most formidable ships in this class, and some of the Armstrong cruisers, such as the Takasago, Blanco Encalada, and Buenos Aires, of little more than 4,000 tons, are strong and fast enough to cause a great deal of trouble, even to such ships as the Powerful, of thrice their size.

In torpedo craft the torpedo-gunboat is now only a survival, as even the new French ships of this type, which look splendid on paper, have been found unsatisfactory in service. The thirty odd British torpedo gunboats, known in the service as "catchers," are too slow to run down torpedo boats, though they are seaworthy little ships. Their supply of coal is so small that they are a hindrance to any squadron. The destroyer, on the other hand, has established its position, and is now being built on a larger or smaller scale by almost every power. In England, it is true, there has been a halt,—perhaps to ascertain whether turbine-propulsion is applicable. Though England is immensely ahead of any other power in this type, France has numerous large and modern torpedo boats, which, if we can believe the French minister of marine, are every bit as good in narrow waters. British naval officers who have had charge of destroyers would not for one moment admit the fact. The destroyer has proved itself a seaworthy, but very fragile, craft. In war it is probable that one half or one third of the British destroyer squadron would always be laid up in the hands of the dockyard authorities for repairs. But the admiralty and the English torpedo-boat builders must be congratulated upon a great and brilliant success, none the less, while all the best qualities of the young officers in command of these formidable little vessels are stimulated and developed.

One result of the war will almost certainly be a demand for cruisers of very high speed and of great coal-supply, for the purpose of scouting. The Elswick type, with a few less guns and a larger coal supply, would be almost ideal for this purpose, as they can run away from armoured cruisers of the Cressy and Montcalm type, which will generally be found with a squadron.

THE NICARAGUA CANAL IN ITS COMMERCIAL AND MILITARY ASPECTS.

By Joseph Nimmo, Jr.

IN the interest of public discussion the editor of THE ENGINEERING MAGAZINE has asked me to write a rejoinder to the article by Professor Lewis M. Haupt on the importance of constructing the Nicaragua canal. I cheerfully comply.

In his attempt to show the commercial importance of the Nicaragua canal Professor Haupt bases his argument upon certain crude unofficial tables compiled by Mr. F. W. Kelly, of New York, from statistics for 1856 and 1857. These tables appear as appendix matter of an official report to the United States congress submitted in 1866, without a word of explanation as to the manner in which the data were compiled,—an essential requisite of authenticity. Professor Haupt might almost as well have gone back to the conditions which characterized commerce in Roman galleys during the Augustan Age. Since 1857 the maritime commerce of the globe has been revolutionized. The most important changes have resulted from the substitution of iron and steel for wood in the construction of sea-going vessels, the adoption of the screw propeller, improvements in naval architecture and in the construction of steam engines and boilers, the construction of the Suez canal, the construction of trans-continental railroads, and the laying of submarine telegraph cables in all parts of the globe. These achievements have changed the whole course and conditions of international commerce. In the antique tables of 1857, upon which Professor Haupt bases his argument, it is assumed that half of the commerce of Mexico, Central America, and Colombia, the whole of the commerce of Chili, Peru, Ecuador, and China, and the entire commerce of California with the eastern side of the United States, "would pass through the isthmus canal," making a total ship tonnage of 3,094,070 tons. In the light of the facts hereinafter presented these assumptions appear absurd to the last degree.

After the same inconsequential manner Mr. F. W. Kelly estimated that the saving to commerce resulting from the construction of an American isthmian canal would have amounted to the sum of $50,000,000 during 1857,—forty-one years ago. Then, upon the basis of this unfounded assumption, Professor Haupt executes a marvelous feat of guessing. Without the slightest reference to the changes which have taken place in the conditions governing maritime commerce during the last forty years, he estimates that this saving would have increased at the rate of one hundred per cent. during each sub-

sequent ten years, and therefore would have amounted to $200,000,000 during 1897. The professor is as much at fault in his arithmetic as in his prophecy. A commerce of $50,000,000 in 1857, doubling each ten years, would have amounted in 1897 to $800,000,000. In the entire range of statistical inquiry I have seen nothing so devoid of reason or logic.

From this visionary and antiquated attempt at discussion I turn to the conditions of the living present. In the light of these conditions, absolutely ignored by Professor Haupt, let us endeavor to determine the range and commercial possibilities of the Nicaragua canal.

1. The city of Manila is situated at about the extreme limit of the assumed possibilities of the Nicaragua route. In a letterdated June 10, 1898, the superintendent of the United States coast and geodetic survey furnished to me the following statement of distances:

	Nautical Miles.
From Manila to New York:	
via Suez Canal	11,565
via Nicaragua Canal	11,746
From Manila to London:	
via Suez Canal	9,600
via Nicaragua Canal	14,680

In coaling facilities the Suez canal route is greatly superior to the Nicaragua route. Besides, the Suez is a sea-level canal, whereas the Nicaragua would involve 220 feet of lockage. These conditions give the Suez route an advantage equivalent to two thousand miles, over the Nicaragua route, in trade between the Atlantic ports of the United States and Manila, and an advantage equivalent to seven thousand miles in the trade between Great Britain and Manila. It is absurd, therefore, to assume that any of the commerce either of the United States or of Europe with Asia would take the Nicaragua canal route.

2. The commerce of Asia and Australasia with the Pacific coast ports of the United States will not involve the use of any inter-oceanic canal. Besides, that commerce is of such a character that in its eastward movement it will be carried over railroads, being composed largely of tea, raw silk, and silk goods.

3. The commerce of Australia and New Zealand with the eastern coast of the United States is relatively small. The conditions of distance, coaling stations, Nicaragua canal lockage, and the fact that a considerable proportion of this trade is carried on in sailing vessels, will inevitably divert such commerce to other routes.

4. The entire commerce of Australia and New Zealand with the countries of Europe will, from the conditions of distance, coaling facilities, and the advantages of a sea-level canal, take the Suez route or the route around the Cape of Good Hope.

5. The commerce of the United States with the Hawaiian Islands will for all time be carried on principally through the Pacific coast ports, and chiefly through San Francisco. The imports from Hawaii, principally sugar, will be transported from San Francisco to the interior of the continent and farther east chiefly by rail.

6. From San Diego, California, to Callao, Peru, there is very little commerce—certainly none which could contribute materially to the traffic of the Nicaragua canal. The dividing ridge of the continent being near the Pacific coast, the commerce of Mexico, Central America, and South America naturally turns to the Atlantic coast, and therefore will not, to any extent, become tributary to the traffic of any trans-isthmian canal.

7. South of Callao, the Cape Horn route affords cheaper transportation for the nitrates, minerals generally, and other products of considerable bulk shipped east, than could be afforded by the Nicaragua route with its 220 feet of lockage and tolls. Such cargoes are chiefly carried in sailing vessels, which, for reasons hereinafter stated, cannot pass through the Nicaragua canal. Besides, the Cape Horn route affords to steamers the advantages of touching at intermediate ports on the eastern side of the continent.

8. The traffic of the Panama Railroad furnishes a fair indication of the possibilities of an inter-oceanic canal. The cost of transportation by the route formed by this railroad and connecting steamer lines on the Atlantic and Pacific oceans is not very much, if at all, in excess of the cost which would be incurred by a canal route involving tolls and 220 feet of lockage. If there had been a large and growing demand for traffic by the isthmus route, such demand would undoubtedly have been indicated by an increased freight movement over the Panama Railroad. But there has been no such increase. On the contrary, the amount of freight carried over the Panama Railroad fell from 287,243 tons, in 1884, to 279,197 tons, in 1896. The tonnage of 1896 is insignificant in comparison with the amount of tonnage carried by the trans-continental railroads of the United States, estimated at about 4,000,000 tons annually,—a development since 1869.

9. The trade between the Atlantic and Pacific coasts of the United States undoubtedly presents the largest possibility of traffic for the Nicaragua canal route; but this traffic is subject to the competition of trans-continental railroads, which competition has immensely reduced the demand for traffic by any isthmian route. This is explained as follows. After the opening of the Panama Railroad, January 28, 1855, commerce between the Atlantic and the Pacific coasts of the United States was carried on chiefly by means of steamer lines connecting

New York and San Francisco with the eastern and western termini of that railroad. But, upon the completion of the Central and Union Pacific Railroads, May 10, 1869, the carriage of passengers, mails, coin and bullion, express goods, and the more valuable freights, was at once diverted to the trans-continental lines, and can never again be deflected to any possible trans-isthmian route. During the year ending June 30, 1869, the value of the merchandise transported between San Francisco and New York *via* Panama was $70,202,029. In the following year the value of merchandise transmitted *via* the isthmus fell to $18,594,255, and it continued to decline, until it amounted to only $3,517,582 during the year ending June 30, 1894.

Since the completion of the Union and Central Pacific line in 1869 five other trans-continental railroads have been constructed. Thus an enormous overland commerce by rail has sprung up, not only between seaboard points on the two sides of the continent, but between interior points of the States of the Pacific coast and interior points in the States east of the Rocky mountains; also between seaboard points and interior points east and west of the Rocky mountains. The isthmian route does not, and cannot, compete for these particular branches of the great trans-continental movement. It is, and must for all time remain, exclusively a railroad traffic.

In this connection let us recall the fact that two-thirds of the people of the United States reside west of the Appalachian range. The products of the Pacific coast States will not in the future be transported to Pacific coast ports, thence by sea and canal to Atlantic seaports, and thence by rail to interior points, when they can be transported much more quickly and at less cost directly by rail from points of production to points of consumption.

10. There are now thirteen trans-continental railroads constructed, or in course of construction, on this continent,—namely, the Trans-Andean, of Chili and Argentina, the Panama Railroad, the Costa Rica Railway, the railroad in Nicaragua projected and partly constructed from Corinto on the Pacific coast to an excellent harbor for large ships on the Blewfields river, a railroad projected and partly constructed from Old Guatemala on the Pacific to a port on the bay of Honduras, the Tehuantepec Railroad of Mexico, six trans-continental lines in the United States, and the Canadian Pacific Railway in British America.

11. The railroad is to-day by far the most efficient avenue of either domestic or foreign commerce. The enormous commercial movements across the Atlantic ocean are sustained by connecting railroad lines, the total traffic of which many times exceeds in magnitude that part of their traffic which constitutes exports and imports in ships.

When railroads come in competition with ships, the former, except under peculiar conditions, take the passenger traffic, the mails, bullion, express goods, and the higher classes of freight, and perishable freight requiring quick transit, leaving to competing water-lines the lowest classes of freights of great weight and bulk. Railroads have also, in many instances, superseded water lines in the carriage of the grosser freights by charging rates but little in excess of the actual cost of movement,—a charge oftentimes quite as low as, or even lower than, can be afforded on the water lines. Thus the trans-continental railroads have broken down the traffic between the Atlantic and Pacific ports of the United States around Cape Horn, and reduced to small proportions the traffic *via* the Panama Railroad.

12. The Nicaragua canal would be absolutely unavailable for sailing vessels, on account of lack of wind at either end of the canal. The cost of towing sailing vessels to the canal, through the canal, and for a considerable distance from either end of the canal, in connection with tolls, would constitute an insuperable obstacle to navigating such vessels by the Nicaragua route. That eminent authority in physical geography, Lieutenant Maury, of the United States navy, many years ago pointed to the impracticability of navigating sailing vessels through an American ship canal.

Subsequent observations clearly prove that what Maury said as to the isthmus of Panama, or Darien route, applies with about equal force to both the east and west coasts of Nicaragua. The utter unfitness of the Nicaragua canal route for sailing vessels is confirmed by the fact stated by the United States board of engineers of 1895,—that the rainfall on the Caribbean coast amounts to "nearly twenty-five feet of water a year." The fact that the direction of this downpour is usually perpendicular to the surface of the earth also indicates the impracticability of the Nicaragua route for sailing vessels.

13. The assumption that the success of the Suez canal route proves that the Nicaragua canal route would be successful is negatived by the fact that the Suez canal has no railroad competitor, whereas the Nicaragua canal route, as already shown, would be overwhelmed by the competition of rival lines. One railroad competing with the Suez canal as sharply as do the trans-continental railroads of the United States with any possible American isthmian canal would at once take from it (the Suez canal) the entire passenger traffic and the carriage of the mails, bullion, express goods, and all the higher-class freights and perishable goods. The result of such competition would inevitably be to bankrupt the Suez canal company.

14. The assumption of Professor Haupt that the commerce of the Sault Ste. Marie canal indicates the success of the Nicaragua canal is

equally fallacious. The commerce through that canal is in the nature of barge transfer, between railroads about seven to nine hundred miles apart, in the carriage of enormous quantities of natural products,— chiefly grain, ores, and coal. It is a traffic which has no parallel on the globe.

15. There are also certain facts which bear strong presumptive evidence against the assumed commercial value of the Nicaragua canal,—*viz.*,

First. The proponents of the scheme have declined to discuss its commercial merits, even when it seemed incumbent upon them to do so in their own defence.

Second. These proponents have opposed, and now steadfastly oppose, any thorough and impartial official investigation as to the commercial merits of their route.

Third. These proponents have made strenuous efforts, both in the United States and in Europe, to raise funds to complete that canal as a private enterprise, but have failed in all such efforts, while hundreds of millions of dollars are seeking investment in the money markets of the world. In a word, the Nicaragua canal franchise and property, from the commercial point of view, are to-day practically valueless.

Eighteen years ago, in my then official capacity as chief of the bureau of statistics at Washington, at the request of the American Society of Civil Engineers, I prepared an official report on "The Proposed American Inter-Oceanic Canal in its Commercial Aspects." I found that under then existing conditions it could secure not more than 1,625,000 tons of shipping. In 1895 I made a careful re-examination of my report of 1880, in order to inform myself as to the effect of the events of fifteen years upon the general project of an American isthmian canal, and found that it is unreasonable to assume that more than 300,000 tons of shipping annually would now pass through the Nicaragua canal, if completed.

Professor Haupt assumes that the recent voyage of the Oregon around Cape Horn demonstrates the military importance of the Nicaragua canal. This assumption does not bear the slightest test of scrutiny. According to the highest military authorities, the availability of the Nicaragua canal route for the passage of war vessels would involve the construction of expensive fortifications at either end, and of defences at all exposed points along its line. It would also be necessary, in time of war, to provide an adequate military guard along the entire line,— a distance of about 170 miles, in a foreign country; also an adequate naval force at either end. All this would be required in order to prevent the destruction of the canal at a hundred vulnerable points, to prevent the sinking of ob-

structions at the entrances to the small artificial harbors at either end of the canal, and for defence against formidable naval and military assault. If the Nicaragua canal had been completed a year ago, such protection of it would have cost twenty times as much as sailing the Oregon around South America. Besides, the necessary defence of the canal would have greatly hampered both the army and navy of the United States, in the performance of mere guard duty, at a most inopportune time. To have attempted to pass the Oregon through the Nicaragua canal without such precautions would have been much more hazardous than the experiment of hitching the Maine to a buoy designated by the Spanish authorities in Havana harbor.

The barrier to navigation interposed by the American isthmus from Mexico to South America affords vastly greater military advantages to the United States than would any artificial channel through it, having a width of only about 250 feet at the surface, especially in view of the fact that men and material of war can be transported across the continent by rail,—a privilege denied to other powers.

The assumed need of an isthmian canal for military purposes is obviated by the fact that an adequate force of naval vessels can be constructed for the perfect defence of our Pacific coast ports at one-tenth the cost of the Nicaragua canal. Such naval force would be ever present, and therefore much more reliable as a means of defence than the shifting of great naval vessels from one side of the continent to the other in time of war.

The importance of proceeding cautiously, and upon the basis of a thorough knowledge of all the commercial and military conditions involved in the proposed Nicaragua canal scheme, is emphasized by the fact that three enlightened nations of Europe have in recent years blundered egregiously in regard to the construction of canals of great cost and magnitude. The canal from Liverpool to Manchester is a blunder and a dismal failure. The Kiel canal, of Germany, has—according to the latest returns which I have seen—secured only about one-seventh the tonnage predicted for it. Besides, it is of doubtful military value. The Corinth canal of Greece—one of the favorite schemes of Nero and for centuries the dream of commercial writers—represents to-day little else than money thrown away.

The congress of the United States has hitherto confined its attention almost exclusively to the diplomatic and engineering aspects of the proposed Nicaragua canal, and has not investigated or ordered any official investigation of its commercial merits.

I plead for a thorough and impartial official investigation both as to the commercial and military aspects of the proposed Nicaragua canal, by a commission appointed under resolution of congress.

AN EXAMPLE OF SUCCESSFUL JETTY CONSTRUCTION ON THE PACIFIC COAST.

By Gwynn A. Lyell.

SAN Francisco bay is the only natural harbor on the Pacific coast, between the Mexican boundary and the straits of Juan de Fuca, where human agencies have never been called into requisition to improve the entrance. All of the navigable streams on the Pacific coast have been more or less hampered by large areas of sand bars, projecting across their entrances, having in some instances a shifting range of two miles or more, usually north and south, with two or three channels of uncertain depth dividing the outflow. Wherever the needs of commerce and population have justified it, the general government has undertaken the improvement of these entrances, having been in some instances partly successful, but only in one instance entirely so,—*viz.*, the entrance to the Columbia river. This great improvement, so successfully completed, is selected as an example for description.

The Columbia river enters the Pacific ocean between a rocky headland, Cape Disappointment (Hancock), on the north, and Point Adams, a low sand spit, on the south, distant from Cape Disappointment 6 miles. The river is about 3¼ miles wide opposite Point Adams. The outermost point of Cape Disappointment extends into the ocean about 3½ miles west of Point Adams, which affords protection to the entrance during northerly winds. Prior to the improvement, three channels of variable depths existed, their location shifting through an angle of about 180 degrees. The main bar channel varied from nineteen to twenty-one feet in depth, and was totally inadequate for the growing demands of commerce.

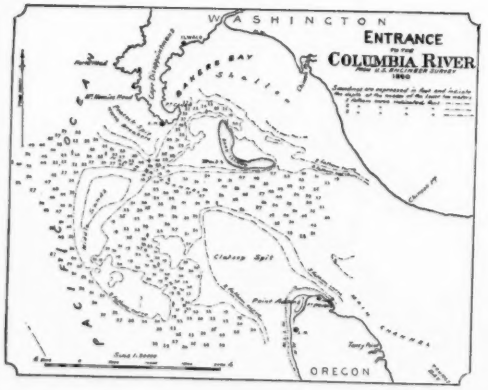
Violent storms occur along the coast, the most violent coming from the southeast and lasting for several days. The westerly winds have a long fetch, and the waves, in extremely stormy weather, comb and break in five fathoms. The United States coast and geodetic survey charts show that, eight to ten miles off the mouth of the Columbia, currents are directed by prevailing winds, northerly in summer and southerly in winter. Under the most favorable circumstances vessels drawing more than 22 feet could not cross the bar, and, as most of the vessels entering the Columbia could load to 26 feet, they were compelled to depart without full cargoes.

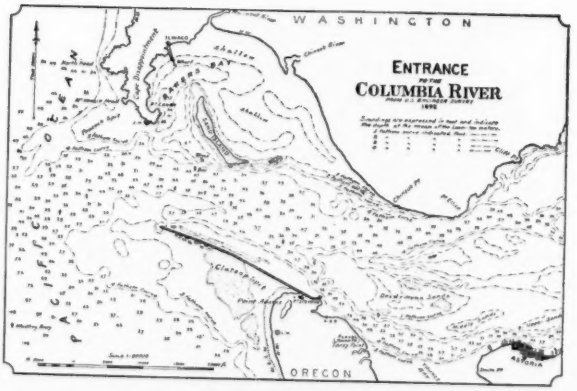
Two prominent headlands are used as landmarks in making the mouth of the river,—*viz.*, Cape Disappointment and Tillamook Head, the latter twenty miles south of the entrance. Tillamook Head is

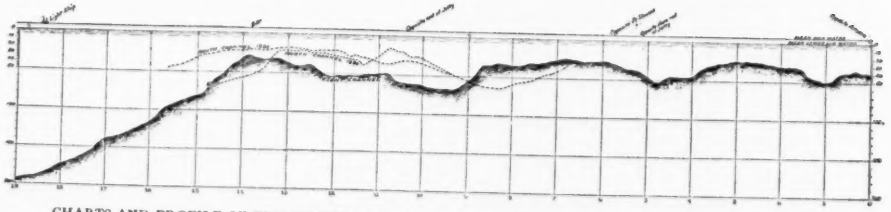
PARADE GROUND, FORT STEVENS.
Showing Jetty and Groins. Cape Disappointment in the Distance.

1,200 feet high, covered with spruce timber, and Cape Disappointment is about 300 feet high and 3 miles long, covered with grass and fern. Point Greenville, a rocky headland, lies sixty miles north of Disappointment, with a low, wide, sandy beach intervening. The bottom of the ocean, for ten miles out, is a hard sand, the average inclination being about five fathoms per mile. The sea breaks at all times in two fathoms, in stormy weather it breaks in five fathoms, and there is evidence to show that it sometimes breaks in ten fathoms. The great current of the northwest coast (the Japan current, or "Kuro Siwo,"), in its passage southward, is about sixty miles off the mouth of the Columbia river. It is said to be about fifty miles wide, and has a black, cold fog hanging over it. Under the influence of the summer northwesterly winds it approaches the main land, and recedes again in winter, under the influence of southerly winds. The currents on the bar undergo constant changes, depending on tides, winds, and outflow of the river. There are strong under currents, heavy winds make dangerous counter-currents, and the summer floods produce tide rips. There is no slack water on the turn of the tide.

The mean rise and fall of tides at Astoria, twelve miles inland, is 6.2 feet; spring tides, 7.4 feet; neap tides, 4.6 feet. The mean rise and fall of tides at Point Adams is about 7 feet. At low stages of the river the tide is perceptible one hundred and fifty miles from the mouth; at such times the average tidal flow at the mouth for the six hours between the lower low water and the higher high water, is estimated at about 1,000,000 cubic feet per second. The freshwater







CHARTS AND PROFILE OF THE MOUTH OF THE COLUMBIA RIVER.

VIEW OF JETTY BEFORE CONSTRUCTION OF GROINS.

discharge is estimated at about 90,000 cubic feet per second at low stage; at mean low stage, 300,000; in great floods, 1,000,000. But the greatest value is attached to the tidal flow for scour, as it is of longer duration than the discharge proper in the summer floods. A velocity of 4.5 miles per hour has been observed opposite Point Adams.

Having no similar work of such magnitude from which any information as to mode of procedure could be derived, save the construction, then under way, of a jetty at Yaquina entrance, a small estuary about eighty miles south, where the conditions were entirely different, the board of engineer officers appointed to formulate a plan for improvement had a perplexing problem before them. This board consisted of the following officers: Lieutenant-Colonels C. Seaforth Stewart, Wm. P. Craighill, C. B. Comstock, and Captain Chas. F. Powell. They met in San Francisco October 13, 1882. The plan approved by this board consisted in building a mid-tide jetty from the extreme end of Point Adams, on a slight curve convex towards the north, the outer end abreast of Cape Disappointment, and distant therefrom about 3 miles, and 4½ miles from high-water mark at Point Adams. This would contract the waterway abreast of Cape Disappointment, and direct the outgoing waters on the bar, without retarding the inward flow to fill the tidal basin. The jetty was to be built of quarried rock, dumped to place from a narrow-gauge double-track tramway. The estimated cost of the jetty was $3,710,000; amount appropriated for the work, $2,025,680. Total

amount expended, $1,837,057.46, which completed the work according to the approved project.

In 1885, the shops, storage platform for piles, and 3,000 feet of inshore pile trestle, besides other work, were constructed. Piles ranging in diameter from eleven to twenty inches were driven with a jet appliance to depths ranging from fourteen to eighteen feet, through sand and a substratum of mud and decayed vegetable matter. The entire site of the work had to be cleared of a mass of drift-wood, much of which consisted of enormous fir logs imbedded in the sand, some of them several feet below the surface.

For the inshore trestle the pile bents were 12 feet centres, 4 piles to each bent, double track 13 feet centres, 3 feet gauge. Rails were of steel, 30 pounds per yard, fastened with splice bars and spiked to 10 by 14 fir stringers, which were drift bolted to 10 by 12 caps, 21 feet long. This portion of trestle was from 12 to 14 feet above the sand spit, and had a 2 per cent. ascending grade out on to the jetty tramway, to a level of about 24 feet above mean lower low water.

From the root of the jetty, seaward, piles 55 to 70 feet long were driven by the hydraulic process, as it was found impossible to set the piles in the sandy bottom of the ocean by the ordinary process. Four piles per bent, braced transversely at top, with 6 inch square timbers, bolted on; caps 12 inches square, 22 feet long; stringers 12 by 16 inches, 32 feet long, making bent interval 16 feet. A foot plank, 3 by 12 inches, was spiked between the stringers. Double track, 14 feet centres. The stringers were fastened with one inch bolts, 26 inches long.

VIEW FROM RECEIVING WHARF.
Cape Disappointment on Right; also Shore Revetment.

HYDRAULIC REVOLVING PILE DRIVER.

The tramway pile-driver was a specially-constructed machine, fitted with a powerful engine and a large Worthington pump for jetting down piles. The driver made a complete revolution on a turn-table fitted with turned steel rollers. A large tender car accompanied the

driver, mounted on six trucks, three over each track, and carried piles, lumber, etc., for a day's work.

An average of about one thousand feet of double-track tramway could be placed per month, under fair conditions, and partially rip-rapped. Fascine mats were used as a foundation upon which to dump the rock, to prevent its sinking into the yielding sand, and were 2½ to 5 feet thick. The inside mats (those between the bents) were 20 by 64 feet, usually of five thicknesses of fascines. They were made under the tracks, on a platform of piles which formed a part of the mat, the whole suspended from the track stringers above, by ropes fastened to specially-constructed adjustable hooks. When a mat was completed, it was lowered to place, the hooks were moved ahead, and another mat was constructed. The depth of water in which mattresses were sunk ranged from 6 to 20 feet. The outside mats were made inshore, on gridirons, and loaded on flat cars provided with dumping rollers. With a good supply of fascines on hand, two inside mats could be made and placed in position in one day.

For the greater part of the jetty the mattress foundation was 40 feet wide. For the outer 300 feet of the jetty it was 70 feet wide, and over this portion the final dumping consisted almost entirely of rocks, weighing six to twelve tons each.

Four low spur-groins, the outer two 600, and the inner two 1,000, feet long, were built out, perpendicular to the axis of the jetty, on the north or channel side, to counteract the scouring and undermining effect of currents racing along the jetty. In all respects these were built like the jetty.

At the close of the season's work of 1894–95 no appreciable settlement of the enrockment had taken place, but at various points flattening of the section had been effected by the surf, and 2,000 feet of the outer end had been much flattened by repeated storms; this, however, was strengthened, but not fully carried up to the required height.

All work on the jetty was done by hired labor.

To construct the Columbia river jetty, 945,923 tons of rock were used, which cost, including tramway, mattress foundation, plant, transportation, superintendence, etc., an average of $2.06 per ton of 2000 pounds, and nearly all of which was transported by water a distance of 108 miles. The cost of dumping rock on the jetty averaged about 11 cents per ton,—that is, hoisting from barges and transporting bycars to place of deposit. This included labor, fuel, etc. As before stated, the jetty was practically completed at the close of 1895.

Of piles there were required something more than 377,000 lineal feet, at a cost usually of 8 to 10 cents per lineal foot, delivered at Astoria. The piles in jetty tramway were 55 to 65 feet long, except at

VIEW ALONG AXIS OF JETTY; LOW TIDE.
Showing Sand Accretion on Left.

the outer end, where 70 foot piles were driven. Over a great portion of the jetty piles were driven in 10 to 30 feet of water.

In times of flood the Columbia carries great quantities of drift, some of it enormous fir logs, and these, being carried back and forth by the tide, played havoc, at times, with the tramway, breaking the piles and otherwise damaging the trestle, all of which added to the cost of maintaining the tramway until it could be sufficiently rip-rapped to protect it.

The tramway, double-track, cost $6.50 per lineal foot, including all materials, labor, maintenance, etc. Piles and timber in tramway were of Oregon fir. There were used in tramways, wharves, etc., 2,723,473 feet, board-measure, at a cost, usually, of $10 per thousand.

Of fascines there were used over 22,300 cords, purchased, besides a great many cut on the government reservation. Fascines cost $2.74 per cord, contract price, delivered at the work. Fascine poles cost 24 cents each. The mattress work, in place, cost $4.50 per lineal foot.

Steel rails cost $45 to $53 per ton, delivered at Astoria. All towing between Astoria and the work was done by the government. Its cost per ton was .034 cents. During the last year of construction an average of 22,355 tons of rock were dumped on the jetty per month.

A building, 30 by 100 feet, was divided into machine, blacksmith, and car shops, for erecting and repairing dump cars, and besides there

was a separate car-erecting shop, 16 by 50 feet. The large shop contained a stationary engine, machine lathes, drill presses, bolt cutters, one blowing fan, and three forges. The engine house had four stalls, with ash pits; conveniently near were coal bunkers, with a capacity of 130 tons of bituminous coal, for use on the locomotives. The other buildings were the office, store-room, etc.

There were two pile-drivers,—the jetty tramway driver and the land driver, the latter being used for building the wharf and inshore end of tramway, where the tramway driver could not be used.

There were twenty-two old-style rocker dump cars in use; as the work progressed, these were found unsatisfactory, being too light and requiring constant repairs. A self-righting dump-car was designed, and forty were eventually built. Their capacity was greater than that of the old style; they were also more easily handled, requiring only one man to dump an entire train of ten or more cars. The cost of these cars was about $450 each; all the iron work, except the castings, springs, and draw-gears, was made in the shops on the work.

There were five locomotives of the Baldwin and Porter type; their weights were 9 to 13 tons. Other rolling stock consisted of five flat cars, three mat cars, and other small cars. On the receiving wharf there were two hoisting engines and derricks, constantly at work, with one hoister and derrick held as a reserve, in case of accident. The hoisters were of the Mundy and Lidgerwood type, with double cylin-

SELF-RIGHTING DUMP CAR RECEIVING ITS LOAD.

TRANSPORTING ROCK.
Tug Geo. H. Mendell Towing Two Barges.

ders, double drums, and vertical boilers. The daily capacity of two derricks was about 600 tons of rock, besides unloading lumber, piles, coal, and other supplies. There were ten model barges employed in rock transportation,—four with a capacity of 280 tons, four with a capacity of 450 tons, and two with a capacity of 295 tons, each. Their cost was $5,500 to $5,800 each. For towing these barges a substantial tug, the George H. Mendell, was built by the government, at Portland; length, over all, 90½ feet, beam 18 feet, draught about 7 feet; engines, inverted compound of receiver type, 18-inch stroke; propeller, 5 feet 9 inches in diameter; boilers, Scotch type, 9 feet 3 inches in diameter, 10 feet long, with 124 three-inch return tubes; 2 furnaces, each 36 inches in diameter. The machinery was built by Neafie & Levy, Philadelphia. This boat was very powerful, easily handling two loaded barges against a strong ebb tide. The cost of tug, complete, was $20,000. It was named in honor of Colonel George H. Mendell, corps of engineers.

In 1893 it became evident that great changes were developing, favorable to navigation. The middle ground, just inside, which had always divided the waters into two channels, had been entirely obliterated. Sand accretion had taken place over a vast area along the jetty. A comparison of the 1885 survey with that of 1892 developed an area, south of the jetty, of 3,200 acres, of triangular shape, over which an accretion, estimated at 30,000,000 cubic yards, had taken place, with an average depth of five feet. At extreme low water

SHORE END OF JETTY. CHANNEL ON THE RIGHT.

about 1,290 acres of this area was bare. The area affected north of the jetty was found to be about equivalent to that at the south side. At the outer limit, or that part next to the channel, which embraced an area of about 1,700 acres, a scouring away of 13,000,000 cubic yards took place. The area next to the jetty at the north embraced 1,500 acres, over which a deposit of 12,000,000 cubic yards took place. The area bare at extreme low water on the north side of the jetty, immediately next to it, was 257 acres. Over the scoured area an average increased depth of 4.41 feet of water was effected. Along the axis of the jetty, sand accumulated with the building-up of the rock above low water, and followed close upon the enrockment as it

DISCHARGING ROCK AT RECEIVING WHARF.

was extended. Over the navigable portion of the new channel the bar survey made in May–June, 1895, developed the following: There was a straight channel across the bar, one-half mile in width, having a least depth of 31 feet, at mean low water. The interval between the 30-foot contours was seven-eighths of a mile; between the 24-foot contours, two miles. This survey also showed an increased piling of sand next to the jetty, on both sides. The south spit had an elevation of 6 to 8 feet above the plane of reference; the north spit was bare at a five foot tide. Both spits showed an increased encroachment upon the jetty, being of the same height in many places.

As completed, the jetty, for a length of more than three miles,

was carried up to mean high water,—in many places above that line. (This was authorized by a board of engineers, convened May 27, 1893.) The outer two thousand feet had its height at about mid-tide. The jetty is 4¼ miles long. A hydrographic survey of the bar was made in the spring of 1896, and no material changes had taken place in the channel.

Mr. G. B. Hegardt was in local charge as assistant engineer for nearly eight years, and much credit is due him for his untiring energy and skilful management. The object of the work has been most successfully accomplished. The mass of yielding sands, the heavy breakers of the locality, strong currents and winds,—all these have been overcome, and the Columbia river jetty, the longest of its kind in the world, is completed. Some settlement along the line of the jetty has taken place, and was expected, very naturally, in so unstable a foundation. Heavy seas in time of great storms may displace some rock; this is a source of great danger to the jetty, but, as long as the sands continue to pile against the jetty, no displacement is likely to be effected, except at the outer end, which receives the severest shock in storms, and which, as heretofore stated, was greatly reinforced by a wider base and larger rock. The vast areas of sand adjacent to the jetty break the force of the waves before it is reached, and thus protect it.

At the present time (December, 1897) vessels of 26 feet draught can safely navigate the new channel over the bar. British vessels have controlled the foreign trade of the Columbia river for years; they are built of iron, and, in comparison with American wooden ships of the same size, have a greater carrying capacity on less draught, and hence are preferred. It was to the advantage of the shipper and producer to take the vessel of the greater capacity for so long a voyage as that from the Columbia river to Liverpool, the destination of the wheat product.

The value of the principal exports—*viz.*, wheat, flour, and salmon—for a period of ten years ending June 30, 1893, was as follows, yearly average values of each commodity for the period being given:

Wheat,	foreign	and	domestic,	value.... $4,485,598.00
Flour,	"	"	"	2,104,351.00
Salmon,	"	"	"	2,511,897.00

For the above period, the yearly average value of all exports was $14,204,608.00. The value of exports for the last four years—*i. e.*, since the channel has been improved—is not attainable. Shipping has increased to a very great extent, and lumber and other shipments have been very large.

NEGLECTED CONSIDERATIONS IN THE ARRANGEMENT OF STEAM PIPING.

By W. Cooper.

THERE are offered in the market to-day a great variety of regularly-manufactured steam boilers, feed-water heaters, filters and purifiers, feed pumps, and mechanical stokers, as well as a great variety of so-called economic appliances,—damper regulators, superheaters, etc. On the steam-generating end of a plant is arrayed this elaborate collection of apparatus, on the development of which much thought and money have been expended. On the steam-using end is arrayed an even more elaborate and complicated line of condensers, engines, reheaters, and various other appliances, intended to get the maximum amount of work out of a minimum amount of steam. When an attempt is made to investigate this mazy array of apparatus with a view of determining the points of merit and demerit, it is found to be almost a hopeless task, owing to the vast variety of combinations.

It seems that, when so much thought and money have been expended upon both ends of the steam plant, at least a small per centage of these might have been given to the connecting link. But, while boilers making steam and engines using it have been developed to a very high degree in the attempts to get the last fraction of a per cent. in efficiency, the link connecting them has been almost entirely neglected. It is assumed that the transmission of the steam from the boiler to the engine is a very simple matter, and that there is no room for improvement over a pipe of sufficient size. It is assumed, again, to be of sufficient size when the velocity of the steam does not exceed a certain number of feet per second, and the calculations of this velocity are based upon yet another assumption.

Here the practice of steam piping seems to have stopped. The fact is, the study of the flow of gases through pipes is a science of no mean degree,—deeper, without doubt, than that of the flow of liquids, as it involves a wider range of varying conditions, on account of the compressibility of the fluid.

That the science of the flow of gases is not yet exact is shown in one of the very latest engineer's hand-books by the deductions from a table on the loss in head in the transmission of compressed air through pipes. From this table it can be shown that it is economical to transmit compressed air at a higher pressure than that required at the outlet, allowing the extra energy stored in the air to escape. In one case a five-fold increase in the terminal pressure decreased the

initial pressure to one-tenth of what it was before the increase of terminal pressure. The error in this case is that the formula used does not take into consideration the fact that the air is compressible. It considers the velocity through the entire pipe to be the same as at the outlet. Since the velocity varies inversely as the pressure, it is evident that it is less at the inlet than at the outlet, for the pressure must be greater to overcome the resistance of the pipe. It is obvious that, if the pressure at the inlet be increased, the resistance to the flow must be increased. This means a longer pipe or higher terminal pressure. In transmitting a given quantity of compressible fluid through a given pipe, the higher the terminal pressure the less the loss in transmission, for the reason that the velocity is less, owing to the increased density. The density of a perfect gas varies inversely as the pressure, and, since the velocity through any given pipe, while transmitting a given weight per minute, varies inversely as the pressure, the velocity varies directly as the density. The loss in head or pressure due to the resistance of the pipes varies as the square of the velocity. If these few cardinal principles are borne in mind, almost any problem may be grappled with successfully. The fallacy of the case cited, where the increase in terminal pressure produced so great a reduction in initial, can be seen by this simple illustration. Suppose that a certain pipe be discharging a certain quantity of compressed air at 60 pounds' pressure per square inch with an initial of 260. The pipe line has been in operation under these conditions for a sufficient time to produce a steady flow through the entire pipe. Suppose the terminal pressure be suddenly reduced to one pound; there is certainly no reason why the initial pressure should increase, but there is a very good reason why it should decrease; less work is being done. The fall in the initial pressure will not be equal to the fall in the terminal, however, for the reason that the mean velocity through the pipe is increased. The loss of head or pressure in the transmission of compressible fluids through pipes increases as the terminal pressure is reduced, but this does not mean that the total initial pressure will be increased. Applying these principles to steam piping, one of the first things of material interest that is discovered is that, as the pressure of the steam used is increased, the size of the steam pipes can be reduced, other things being equal.

In the flow of liquids through pipes there is one factor that does not change; the velocity is uniform throughout the pipe. For a steady discharge there is only one variable factor,—the resistance, depending upon the size and kind of pipes. In the transmission of liquids through pipes the loss of head is a constant, regardless of the pressure, while in the transmission of gas it varies with the pressure. Although

the study of the flow of liquids and gases through pipes with a uniform discharge seems somewhat complex, it is simple in comparison with an intermittent discharge, which sets up in the pipe vibrations and pulsations materially affecting the result. This is, of course, of far more moment in liquids than in gases. The effect of the sudden interruption of the flow is almost exactly the same in either case, and is governed somewhat by the specific gravity of the liquid or gas. The law governing this, however, is not the same in liquids as in gases, owing to the compressibility of the gas.

If the rapid flow of a liquid through a pipe of considerable length be suddenly interrupted, a "hammer" is produced which can easily be made to burst the pipe. In the case of a gas under these conditions the "hammer" is not so violent, but it sets up vibrations which indicate a loss of energy. When the valve on one end of the steam cylinder opens, the steam rushes in, and the whole mass of steam in the pipe is set in motion. The valve closes, and the motion is arrested. The steam, being elastic, recoils, and, while it is on the recoil, the valve again opens, and it again rushes forward, the valve closes, and the cycle is repeated. This recoiling of the steam in the pipe is the power that shakes the pipe and surrounding objects. Where the steam pipe vibrates and shakes, it is proof positive that energy is going to waste.

The vibrating of the steam pipes can be obviated as a "hammer" is obviated where liquids are to be handled with intermittent discharge,—that is, by providing a cushion for it to operate against. This is accomplished, in a pump, by providing a chamber wholly or partially filled with a compressible fluid which absorbs the energy of the momentum of the liquid, returning it to the liquid between discharges. In supplying steam to a steam engine the flow can be made uniform through the pipe, and the inequality of discharge equalized, by providing a chamber of sufficient size immediately at the opening into the engine cylinder. The steam, being compressible, absorbs the energy of the momentum of the flow through the pipe, or, in other words, maintains a constant and uniform flow through the pipe. The action of the steam in this chamber is simply this: when the valve opens into the cylinder, the steam in the chamber expands and fills the cylinder without producing any extra motion of the steam in the pipe. This can be seen by supposing the steam pipe to be cut off from the receiver for the time being. The volume of steam in the chamber would expand, filling the cylinder and reducing the pressure in the chamber in the ratio of the volume of the chamber to this same volume plus the volume of the cylinder. The steam in this chamber expands without producing momentum, because there is no resulting

motion. When steam is supplied to the receiver at a uniform rate, the pressure is never reduced to the minimum, or to what it would be in the case just supposed. The action of the receiver tends to maintain a mean between the maximum and the minimum, and it is obvious, that, the larger this receiver, the less the difference between the mean and the maximum pressure.

In connecting the boilers to the engines the first point to be taken into consideration is the amount of steam to be transmitted. This can be determined approximately by the horse power of the engine multiplied by the probable consumption per horse power. After the amount of steam has been determined, the density can be calculated from the pressure. Knowing the density and the number of pounds per unit of time, the size of pipe can be determined, if the allowable velocity is known. Here the first difficulty is encountered; determination of the allowable velocity for any given case is very difficult.

In almost all cases the size of the steam pipe is either determined by "rule of thumb" or calculated on a certain velocity per second. The former plan is as good as the latter, if the velocity has—as is the case in almost every instance—been assumed. The question really is: what shall be the velocity of the steam through the pipe?

It is generally assumed that the size of the pipe for the engine should be determined by the opening into the throttle. If this be eight inch, then the engine should be piped with eight-inch pipe, regardless of everything else. Great inconsistencies naturally result from this method. One maker may believe that it is more economical to pipe an engine with small pipe, on account of the question of radiation, cost, etc., than to use large pipe. Another maker may believe it safer to make the pipe "large enough." Sometimes, as a result of this, 200 h.-p. engines are piped with the size used by another maker for an engine of 1000 h. p. This is certainly very different from the almost absolute consistency that exists between different makes of engines in regard to size of cylinder, etc.

In many cases the steam pipe is little less than a continuation of the engine cylinder in point of diameter, while in others it seems absurdly small in proportion to the diameter of the cylinder. The first condition comes from the fact that in some cases, where a great drop in pressure has been found between the boiler and the engine cylinder, the natural remedy is to increase the size of the steam pipe. This has been done in many cases by actual change in the piping of the whole plant. In many other cases the engine builder has recommended the use of larger pipe than that used in some other plant in which a similar engine had been installed. Of course better results followed these changes, but in some cases only to a very limited degree. Then, on

the theory that the way to improve on a good thing is to have more of the same kind, the size was increased again, until in some cases it became absurdly large. These inconsistencies prove only that the science of piping is not yet exact. The fact is that in a great majority of cases the pipe is far larger than is necessary.

If it is determined that a certain size of pipe is the most economical for a certain engine working at a certain pressure, a pipe of only half that size is sufficient with twice the pressure. If the size of pipe has been determined for any given case, increasing the length does not necessitate an increase in size, except beyond the point to which the determination has been made. That is, theoretically the size of a steam pipe should increase as it advances. While this is true theoretically, all ordinary cases can be covered by a pipe of uniform diameter.

It has never been definitely determined just how small a steam pipe can be used when all conditions are correct. In the installing of steam piping the first thing to be considered is the size of the receiver. It should be about fifty times the volume of the steam admitted to the cylinder at each valve opening. Under these conditions, if the steam-pipe supply were cut off entirely, the pressure would fall only one-fiftieth of the initial. But, as the steam-pipe supply is uniform under these conditions, it tends to keep up the pressure, and will hold it at a mean between the maximum and the minimum. The receiver should be placed as close to the cylinder as possible, in order to reduce the recoil action to a minimum. With a receiver of this capacity immediately next to the cylinder, the size of the steam pipe to the boilers can be reduced to a point that seems absurdly small. As an illustration, a 1,250-h. p. engine can be run by a pipe 100 feet long and 6 inches in diameter with not more than three pounds' drop in pressure. This seems a small pipe for this size of engine doing nominal or maximum work, and it certainly would be small, were it not for the receiver at the opening into the cylinder. This receiver acts as a reservoir from which the steam admitted to the cylinder at each valve-opening is drawn, thus in no way effecting the flow through the pipe. Under these conditions the drop in pressure will be approximately the pressure required to force the required amount of steam through the given pipe, the loss in pressure being friction alone; no energy is lost in producing vibration and hammer blows in the pipe.

If the drop in pressure between boiler and engine is caused by friction in the pipe, the energy represented by this difference in pressure is absorbed by the steam, tends to superheat it, and saves just that amount of condensation. On the other hand, if the drop in pressure is caused by the pulsations of the steam in the pipe, the en-

ergy represented by this drop is lost, being absorbed by surrounding objects to which the pipe is attached. It is better, then, to err on the side of making the pipe too small than to err by so erecting the pipe that it will be shaken by the recoil of the steam. A velocity of two hundred feet a second can be allowed without producing an uneconomical drop in pressure. It is desirable to obtain the maximum economical drop in pressure.

In installing steam piping care should be taken that the pipe used be as smooth internally as it can be made at reasonable expense. Much of the iron pipe on the market is entirely unfit for steam purposes, as its internal surface is very rough, especially in the small sizes. Steam pipe four inches and more in diameter can be much improved by grinding on the inside. Besides this method, there is a process of glazing that should give very good results. However the pipe is treated, it should be made comparatively smooth on the inside. It need not be polished, but should be free from scabs and humps, and should present a surface on which a film of water will make a complete skin. It will pay handsomely to use such a pipe, even if the cost be doubled. If the pipe be put in this condition, a much smaller pipe can be used in so far as friction is concerned, and the loss from radiation is much less. Given pipe in this condition, there need be but little fear of making it too small. It is allowed that calculating the size from the figured velocity is only educated guess-work, for there are few, if any, reliable data on which to base the assumption of the allowable velocity. If calculations are to be based on guess work, then guess-work will answer as well for the final result. If guess-work is to be the basis of the calculations of size of steam pipe, the guessing should be guided by the knowledge extant. Many instances can be cited, and many authorities quoted, proving that under no circumstances should a velocity of twenty feet per second be exceeded. On the other hand, a few instances can be cited where a velocity of more than seventy feet per second has been used with perfectly satisfactory results. Now, if a single instance can be cited where a velocity of seventy feet per second has been used with economical results, it is proof that this velocity is not too high. It can be shown that, even at a pressure of one hundred and sixty pounds per square inch, it is economical to use a velocity of one hundred feet per second, and this with common iron pipe.

It is not beyond the range of possibilities that a velocity of three hundred feet per second can be used economically, if the arrangement of receivers and the radii of elbows are what they should be.

The science of steam piping resolves itself principally into preventing the energy from leaving the pipe either in the form of heat or of

work which will be turned into heat as it is expended on surrounding objects. If the pipe be covered with a non-conductor, so that the radiation is reduced to zero, and if there is no work being done in shaking pipe and surrounding objects, then no energy is escaping from the pipe. If no energy is escaping from the pipe, and if there is at the same time a drop in steam pressure between boiler and engine, it is a question in the science of superheated steam whether there is a loss in transmission or not. If this be carried to an extreme, there will be a loss. For instance, suppose a non-condensing engine is supplied with steam through a pipe in which the radiation factor is reduced to zero, and that all the pressure generated at the boiler is consumed in forcing the steam through the pipe, so that at the engine the steam has just the pressure of the atmosphere. Under these conditions the steam is highly superheated, but has no power to do work, for there is no pressure to move the piston. It is latent energy, and must be passed through another transformation before it can be made to do work. It is much the same as the latent energy of the coal.

On the other hand, suppose that under these conditions the steam is delivered at the engine just sufficiently superheated to compensate for the condensation in the engine cylinder. Under these conditions is it not reasonable to say that no energy has been lost?

In operating throttling engines it is often found that it is impossible to make steam enough to keep the engine up to speed, if the boiler pressure be kept at the initial pressure in the cylinder, or a little above it, while, if the boiler pressure be doubled, steam can be supplied with ease. This seems almost like a paradox,—like compressing a spring to two pounds to do work, and then allowing it to spring back to one pound before applying it to the work to be done. But there is no paradox about it. The phenomenon can be readily explained on the theory of the steam engine as a heat engine. It is evident that, if the boiler pressure be doubled, more energy is stored in each pound of steam generated. Since the efficiency of the steam engine considered as a heat engine is $\frac{T-t}{T}$, it follows that the heat converted into work is the sensible heat. Doubling the pressure increases the sensible heat in the steam, and, in the case of a throttling engine in which the pressure is reduced at the throttle, a portion of the sensible heat appears in the form of superheat. If the temperature of the steam entering the cylinder is higher in one case than in the other, it follows that $\frac{T-t}{T}$ is increased; therefore the efficiency of the engine is increased, other things being equal. It is obvious that, if this superheating be carried to the point where the exhaust is slightly superheated, the

efficiency of the engine, considered as a heat engine, is maximum under the conditions. If the exhaust is superheated to any considerable extent, the efficiency of the apparatus falls off, for latent energy is being wasted.

The science of superheated steam accounts for the good results of many throttling engines. Many throttling engines have shown as high an efficiency as that shown by some automatic cut-off engines. This is due to the fact that the engine uses steam that has been superheated by being "wire drawn" through the throttle valve, thus introducing the energy into the cylinder in a condition to be better utilized than in the case of an automatic engine in which the refrigeration due to excessive expansion neutralizes the advantage of high initial pressure.

Underlying all this is a cardinal principle often overlooked. Energy cannot be annihilated. Then, if no energy escapes from the steam pipe, all the energy of the steam at the boiler must enter the engine cylinder. Whether it enters the cylinder in shape to be utilized or not depends upon conditions.

From the statement that all the energy of the steam at the boiler enters the engine if none escapes from the pipe, it follows that, if no energy escapes from the pipe except in the form of heat, all of the energy of the steam at the boiler must enter the engine, except that lost by radiation. The amount of heat lost by radiation depends upon the difference in temperature between the pipe and the outside air. If the steam be superheated by its passage through the pipe, the extent of this superheating will be so slight that under ordinary circumstances the difference in radiation will be of no account. It is, then, safe to say that there will be no increase in radiation due to superheating. Therefore the same amount of energy per pound of steam will enter the cylinder regardless of the velocity in the pipe, up to the point where the superheating effects the radiation. It is probable that the superheating would be carried to the point where it would affect the temperature of the exhaust before it would materially affect the radiation.

Now, if this superheating does not affect the radiation, and the exhaust is saturated steam, where has any energy been lost? Just where this superheating should cease, and how small the steam pipe should be made to produce the desired result, are difficult points to determine. No attempt will be made here to do this, but it can be stated with a fair degree of certainty that with the highest pressures a velocity of at least two hundred feet per second can be used. It is needless to say that there are many advantages in making the steam pipe small, besides the first cost of the pipe itself. It is easier to erect and provide for expansion, etc., the radiation factor is very

much reduced, and, in general, the cost of installing, maintaining, and operating is less. On the other hand, what is the actual loss in the transmission due to the drop in pressure? If the drop in pressure be caused by the resistance of the pipe only, and this goes to superheat the steam, it is evident that it can be carried to a considerable extent before it will more than offset the saving effected by making the pipe small.

Reasoning from the foregoing, it is evident that in most cases the use of smaller pipe would have produced better results. From the foregoing, too, it might be inferred that, if friction causes no loss in the transmission of the steam through the pipe, it makes no difference whether the pipe be large or small, smooth or rough. To preclude the possibility of such an inference, it may be well to reiterate the principle on which this statement is based. The resistance to the passage of the steam through the pipe superheats the steam. If this superheating does not exceed the amount of condensation in the pipe and engine cylinder, no energy is lost. Thus there is a limit beyond which superheating should not be carried. It is also evident that, the smoother the pipe is internally, the less the resistance, or the smaller it can be made for a given resistance. The amount of drop in pressure allowable in any given case cannot at present be determined. It is stated, however, by a good authority, that about one hundred degrees of superheat will compensate for any ordinary case of cylinder condensation. It is also stated that a superheating of from forty to fifty degrees effects a saving of fifteen per cent.

As the initial pressure is increased, the amount of superheat per pound of pressure of free expansion decreases. It is about two degrees per pound at atmospheric pressure, while it is only four-tenths of a degree at one hundred and fifty. From this it is evident that the drop in pressure in the pipe would have to be large to entirely compensate for cylinder condensation.

On the other hand, as the size of the pipe is reduced, the amount of steam that will pass per second will be reduced; and, if the pressure at the boiler is not increased, the power of the engine will be reduced,—not, however, its efficiency.

The ideal arrangement is an engine designed to use superheated steam of a certain amount of superheat at a certain cut-off, for its nominal load at maximum efficiency, with a boiler designed to generate steam at a pressure so much higher than the cylinder pressure that a reduction in pressure by passing the steam through a small pipe connecting them will give the required pressure and superheat at the engine. The drop in pressure required to give this result is about one hundred pounds with two hundred and fifty pounds at the boiler.

EFFECTIVE SYSTEMS FOR FINDING AND KEEPING SHOP COSTS.

By Henry Roland.

THE HYATT ROLLER BEARING COMPANY'S PRACTICE.

ALTHOUGH, speaking generally, one Hyatt roller bearer is similar to another, there are at the present time about two thousand different bearings classified in the Hyatt factory, no two of which are alike in cost; hence quite as much variety is demanded in keeping the Hyatt factory cost accounts as in any ordinary jobbing machine shop of the same size, while at the same time the apparent similarity of the different lots of work produced very easily leads to an unitemized practice in cost estimates, which, as practical factory accountants well know, is productive of purely guess-work totals of the most misleading character. Indeed, it may safely be said that any cost-keeping system based on assumption at any material point of its practice merely throws away the money which it costs to maintain it, and would better be terminated at once. A cost-keeping system should at least be homogeneous, and, if exact in part, should be exact as a whole, because an imposing array of figures, although based on assumptions which may be far from approximating the actual outlays, is much more impressive to the average mind than avowed guess-work, so that a substantial error in assumed costs carefully carried through an elaborate system of cost books is much less liable to be detected and rectified than if the cost estimate was avowedly the mere conjecture which it always must be if not verified by actual charges of the utmost attainable accuracy.

When Mr. Tellefsen undertook the management of the Hyatt establishment, there was nowhere recorded any accurate information as to the cost of its products. Bearings of certain dimensions were said to cost certain amounts, and were sold at prices based on these asserted costs, which were, in many instances, it is almost needless to say, very far indeed from even tolerably close approximations to the actual figures, as obtained by the use of the three loose blanks and the single cost book which embody the entire machinery of Mr. Tellefsen's cost-keeping methods.

The Hyatt roller bearings are made in a vast variety of diameters and shapes, adapting them for use in machines of almost every description. The bearing consists of soft steel rollers made of coiled flat-steel bars, which travel round and round in a sheet-steel shell made in two pieces with angular margins of junction, confined in cast-iron bearings or hanger boxes of suitable exterior forms. Half of the rollers in each bearing are caged in brass cages, thus en-

HYATT ROLLER BEARING CO., Newark, N.J.

Their No..... SHOP ORDER. Our No.....

Special Instructions Date .....189..

Make for .....

Ship to .....

Via:..... To be Completed .....

Completed.....

Invoice ..... Per.....

FIG. 1. OFFICE ORDER TO SHOP.

suring their own parallelism, and also the parallel movement of the remainder of the rollers, which run free in the journal box.

Fig. 1 is a reduction of the Hyatt office order to the shop. The size of the original is $5\frac{3}{8}$ inches $\times$ $8\frac{3}{8}$ inches, which makes a wide line space, and increases legibility. This card is printed on stiff paper, and has pinned to it when it is sent into the shop the card shown in Fig. 2, size $5\frac{1}{2}$ ins. $\times$ $8\frac{1}{2}$ ins., which is ruled in three divisions, the first for standard stock parts to be drawn on the order from the finished store rooms, the second division for regular castings taken from the rough stores, and also containing space for entries of sundries, while the third division contains in five lines the final cost totals, so that this single card is made to include the final office record of flat cost of materials and labor, and the total cost, with the per cent. additions for shop expense and office expense included; thus the entire accounting history of the order is contained on this one card, which may, of course, be filed, card-index fashion, in a very small space, so that the card of any order in a year's work, or even more, is instantly accessible. Card filing is, in many particulars, very much to be preferred to a transfer to the pages of a book, as the books are more cumbersome, more expensive, and more difficult of reference. In this card (Fig. 2) all of the shop entries are made by the department foreman. The entries in the final division of six items of totals are made in the office, so that the card serves its two purposes of a current and a final record in a very perfect manner, as it gives no general information, or total cost information, until after the final six entries are made on the card after its return from the shop. This is a highly meritorious combination, and one which is not altogether obvious, in the light of what has been previously detailed in

WEIGHTS OF MATERIALS USED IN

.....BEARINGS.

Order No..... ... Order Entered .....

	Size of Stock	Grade	Size	Weight	Cost	Amount	
Rollers, - -							
Yoke, - -							
Lining, - -							
Sleeve, - -							
Castings, { Brass / Iron							
Sundries, - -							
Total Cost of Materials Used, - - -							
Total Amount of Labor, - - - -							
.. % for Shop Expenses, - - -							
% for Office Expenses, - -							
Total Net Cost, - - - -							
Amount of Invoice, - - -							

FIG. 2. COST CARD.

these papers, although it is, in point of fact, exactly analogous to the Strieby and Foote single card. But it is not always the case that we instantly perceive the propriety of following the best practice, even when distinctly pointed out in the conduct of another. The matter tabulated in the final six items of the Tellefsen shop order card is almost invariably separated from the stock card in cost-keeping practice, and is usually kept in a separate book, often locked, and often not in any immediate contiguity to the shop order, although the information contained in the shop order is always an essential part of the conditions leading up to these final totals, and the final totals are often cryptic when read apart from the shop order.

Any degree of privacy in the final disposition of these shop orders after they have been made to include the total costs may be had if they are subjected to card-index filing, as a locked cover to the filing case is just as secure as total cost volumes with locked covers in a locked cabinet.

Having received the office order, as shown in Fig. 1, the shop foreman proceeds to fill the finished-stock and rough material parts of it from the store-room, and to give these requisites, with a workman's time card, as shown in Fig. 3, size 5 ins. × 8 ins., to the man who is to perform the needful labor on the order. This time card may have the workman's number supplied in the office, if thought desirable; such is the practice in the Hyatt shop, which does not employ so great a number of workmen that the manager has no knowledge of their personality.

It will be observed that the card is made for the full week of seven days, and that it has three lines of special accounts, "New Tools," "Repairs," and "Expense," at its head. As the workman himself fills out this card, he is his own judge of what shall be charged to new tools, what shall be charged to repairs, and what shall go to the "expense" or "shop" account,—three items which can easily be made subjects of controversy even among expert cost accountants. "Expense" is a general item, which may include anything or nothing, and some shop cost keepers abolish "expense" and "shop" entirely from the list of chargeable accounts, asserting that these exchangeable items open the way for a noteworthy percentage of inaccuracies.

"New tools" is rated as an assets item, invariably, while "repairs" are charged in the expense account. Mr. Tellefsen has formulated this theorem: "Whatever is a direct factor in the production of salable goods is an asset;" and he governs himself by this assertion. Hence, if a bar of tool steel is given to the tool smith to forge into lathe and planer tools, these tools are considered assets,

TIME CARD

HYATT ROLLER BEARING COMPANY,

No. ..... Week ending .....189..

Name .....

Dept. .....

Order Number.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Remarks.
New Tools								
Repairs								
Expense								
TOTALS								

FIG. 3. WORKMAN'S TIME CARD.

having a value composed of the shop cost of the tool-steel bar and the total cost of the smith's labor. But, when these tools have been worn by use to where they must go to the smithy again, this labor is charged as "repairs," and goes into the expense account. Or, suppose a new boring bar, having a multiplicity of cutters, is made,—such tools being largely used in the Hyatt shops,—the total cost goes into the assets, and is inventoried as a profit item. But repairs on this multiple boring bar, even if these repairs involved an entire new set of cutters, made from new tool steel from the stock room, would be charged as repairs. If the new cutters made of new stock were credited as new tools, it would appear in the inventory that this particular boring bar had two complete sets of cutters, whereas, in fact, it has simply had its worn out original set of cutters made good.

But, by parity of reasoning, it at once appears that, while the number of lathes and planers, say, remains unchanged in the shop, the shop should never be credited in the inventory with possessing more than one set of small tools for each machine tool; hence the forging of new lathe and planer tools, and the cost of the new bar of steel from which these tools are made, should go to the repair account, as expense, instead of into the inventory, as an asset, in case these new tools merely replace old tools which have been worn out. This practice keeps the inventory correct, if small tools are accepted assets. Many factories charge all small forged tools, such as lathe and planer tools, boring-bar cutters, and so on, directly to expense, and there is little question that small drills, files, and hack-saws should go with the oil and waste into the expense. But there is always a feeling that large drills, which are often costly, especially if made above the usual lengths, and which, though speedily worn out if constantly used, last perhaps for years, if used only occasionally, should be regarded as permanent additions to shop equipment, and hence should go into the inventory as assets. Fluted reamers are closely analogous to drills in shop use, yet, unless subjected to much more violent usage than is the common custom, most cost keepers would be inclined to place an expensive set of new fluted reamers among the shop's assets, instead of charging the cost in a lump to expense the day the reamers were delivered to the tool-room. But circumstances alter cases, and, where a fluted reamer is in constant use, as, for instance, in the Baldwin locomotive shops, where a man, in bolting the cylinder castings together, uses no other cutting tool, the reamer is rapidly destroyed, and, rightly enough, is charged directly to expense. Still, even in the case of this severely-used fluted reamer, which is often worn out and replaced, it makes no practical difference whether the first cost is carried on the inventory as an asset, or is

placed at once in the expense account, if, according to Tellefsen's formula only the original tool is credited as an asset, while the frequent replacements of the fluted reamer are charged to expense.

The total drawing-room account is charged as expense, because the making of the drawings of any new bearing always precedes the estimate given to the prospective customer, and, as the possible customer may not make the order finally, it is safe to consider the entire drawing room charges as expense, and be done with the matter.

The pattern-making item is large, and is separately kept. All of the foundry patterns are of cast iron, and the wooden patterns from which the cast-iron patterns are made form a part of the cost of the iron patterns. Since the iron patterns are used directly in the production of salable goods, it follows that the pattern shop account is a credit, and goes into the inventory as an asset.

When the workmen's time cards and the foremen's shop order cards are filled and returned to the office, they are transferred to a flat-cost record book, the size of the page (shown in Fig. 4) being 11¾ inches × 9¼ inches. The illustration gives only the left-hand portion of the page, additional order columns extending the width to the 11¾-inch dimension given. The head line is for order numbers, which can be duplicated in adjacent columns, if one column has not room enough. The first line of footing totals is for pattern making, the second for other labor, and the third is for regular items from the finished stores room, with ample space for sundry and unclassified items. The final line of totals gives the flat cost, or prime cost, and from this the total cost is made up of these flat-cost items, the percentages for shop expenses and office expenses being added. These percentages are calculated from previous performances, all records including the value of output for the month in which the performance occurred, which is another form of "number of men in work," and is perhaps the more correct basis of expense apportionment.

The shop-cost items include interest and taxes on realty, depreciation of tools (which is calculated on a basis that always preserves a value), insurance, and repairs. The office expenses include all office and management salaries, supplies, advertising, and travelling and sales expenses.

With these constant expenses, or expenses which, if not constant, may be larger when fewer men are in work and the monthly output is smaller, it is, of course, absolutely essential that the total value of the output for some stated period be selected as a basis of computation, since, in case of a $5,000 output per month, the expense percentages would be twice as great per dollar of output if the expense remained constant as if the output were $10,000 for the month. All

of the expenses have been carefully computed for a long series of months, and the expense percentages for shop and office are tabulated with their totals of selling production, and the resultant shop and office cost percentages. For current estimates this preceding tabulation is consulted, a period being selected in which the output of salable product corresponded in value with what is assumed as the probable output of the current similar period. At the end of the year all of these periodic expense percentage assumptions are tested by comparison with the actual expenses, and are invariably found to fall within a wholly insignificant percentage of error. This is what might be expected by experienced shop accountants, who well know the surprising uniformity of expense additions demanded in proportion to the number of men in work, or the total value of output for a limited period of time.

Mr. Tellefsen believes that the error in his estimates averages considerably less than one per cent., and even says that he himself has often been surprised at the close coincidence of his estimates and the actual total costs as shown by the completed account of finished work.

The time card gives the workman's own account of his shop time.

This is mechanically checked by a simple and effective form of time-recorder, so arranged that, by the mere pushing of a button, a record is made, on a ruled sheet, of the time of each workman's entering and leaving, the record being in such form that it can be filed and compared with the time entered by each man in his card.

The importance of a mechanical recorder for workmen's time cannot be over-estimated, especially in connection with any cost system in which the workmen make their own entries on the cost cards, as it eliminates all possible chance of controversy, and a comparison of the mechanical record and the time card filled out by the workman settles every question likely to arise between the men and the paymaster.

A number of effective machines for the purpose of checking the time of entrance and departure are in the market, some being operated by keys, others by stamps, and still others by pressing a button. Even the old method of using metal checks may be used to afford an independent record, which, although made by the men themselves, can be made under such conditions that falsification is impossible. The mere knowledge that such an independent check exists makes the men see to it that the entries on the cards agree with the record.

The Tellefsen cards and cost totals book are applicable to any number of workmen, and three cards and one book contain the entire mechanical part of the system, which thus appears to have the great merits of simplicity and wide adaptability. At the same time, the record kept can be made as full as is desired, any degree of details in account-keeping being practicable.

ORDER No.										
	Man's No.	Hrs.	Rate	Amount		Man's No.	Hrs.	Rate	Amount	
PATTERN MAKING										
TOTALS										
LABOR										
TOTAL LABOR	Kind or Size	Lbs.	Cost			Kind or Size	Lbs.	Cost		
Rollers Compo. Lining Sleeves Cast Iron Sundries										
TOTAL COST										

FIG. 4. PAGE OF FLAT COST BOOK.

The department foreman is made accountable for store-room supplies delivered, and the workman records his own fractional time, which must coincide in its total with the mechanical recorder sheet impression also made by the workman himself, instant discharge being placarded as the penalty for touching the button belonging to another workman under any circumstances whatever.

As to estimates, no nearer approximation to accuracy than that afforded by Mr. Tellefsen's method of tabulating previously-ascertained expense percentages for certain outputs in determined time periods seems possible.

No cost-keeping system which is not carefully maintained can be a real aid to exactness, and, if a manager permits a cost clerk to "estimate" even minor totals rather than incur the labor needful to ascertain what such totals actually are, he cannot expect that feeling of confidence which a knowledge of certainties alone can give. But, if any manager of a machine shop will inaugurate the simple system devised by Mr. Tellefsen, and see that its easy conditions are faithfully followed, he will certainly find himself accumulating, day by day and week by week, a knowledge of what he is actually doing that he never had before, and that, too, without a large addition to his clerical force or to his office capacity.

It is an open question whether the workman or a time taker should take the workman's detailed time record. Both methods are largely used, and there are strong arguments in favor of each. It is, perhaps, cheaper for the shop, in first cost, to have the detail time of the workman taken by a time clerk than to have each workman record his own time on a time card, and errors may be written by either method. With workmen of very small education the time card is quite as likely to be correctly filled as where the mechanic has greater clerical ability; it seems more a matter of natural inclination toward business accuracy than of literary acquirements, and some workmen who know but few words of English always fill their cards correctly, while some of the best mechanics are not above frequent errors. Time-takers are also liable to errors and misunderstandings, and, as previously remarked, the question is open, with the weight of greater use in favor of having the workman fill an individual card.

If the workman's self-filled time card is accepted, it is difficult to see how a record of cost items can be brought into the office at less expense than that involved in the use of Tellefsen's cards and a mechanical recorder, or how the record can be completed by less clerical labor than that required to fill the Hyatt flat-cost book and add the total cost percentages to the shop order card.

HEATING AND SANITATION OF PUBLIC INSTITUTIONS.

By W. N. Twelvetrees.

IN all large public institutions, and especially in such as are specially devoted to the restoration to health and strength of those who are suffering from disease or other ailments, heat plays a most important part.

The point at which it is generated and from which its power, in various forms, emanates in every direction is the boiler house.

As steam, it is led captive in pipes, to aid in the warming of the surrounding buildings, in the cooking of food for their inmates, in the heating of water for a variety of purposes, and in the operations of cleansing and disinfection.

Among other useful functions it provides the motive power for the generation of electric light, and for the operation of machinery, and for the pumping and distribution of water.

The varied applications of heat in such institutions, forming the object-matter of the present article, may be most conveniently examined by considering the methods adopted in a typical establishment. As affording in every way a complete illustration of our subject, the Brook Hospital, at Shooter's Hill, has been selected.

Erected by the metropolitan asylums board at a cost of more than £280,000, this hospital is probably the largest establishment in the United Kingdom for the care and treatment of those suffering from infectious diseases.

For permission to inspect the hospital the writer is indebted to Mr. Duncombe Mann, clerk to the metropolitan asylums board, and to the medical superintendent, Dr. MacCombie, both for a very courteous reception and for the photographs from which some of the illustrations have been made.

Rising from the low-lying ground which borders the Thames, Shooter's Hill is the most commanding eminence in the north of Kent, and from its summit, crowned by the mimic fortress of Sevemdroog, a magnificent view of the surrounding country may be obtained. In the north, beyond the river, are the marshes and the wooded heights of Essex ; in the south and east are the verdant slopes of Kent ; to the west may be seen the heath-clad hills of Surrey, and the great metropolis.

Various circumstances combine to render the site chosen extre-

mely appropriate for a health-restoring institution, such as the Brook Hospital.

The surrounding district rests upon the chalk formation which extends from New Cross to Dover. Above the chalk, Shooter's Hill, an isolated mass of London clay, surmounted by a thick layer of gravel, rises well above the mists and fogs to which the lower-lying lands near the river are subject. Health-giving breezes are borne across the hills from the open sea, and the purest of water is obtained directly from an adjacent pumping station of the Kent waterworks.

Here, then, are three of the chief essentials for health,—a dry and elevated situation, fresh air, and pure water. Moreover, being built on the south-western slopes of the hill, the hospital is admirably sheltered from both the north and east winds.

In times past Shooter's Hill was not unknown as a health resort, for a mineral spring still existing in the neighbourhood is said to have been used by Queen Anne. John Evelyn, who somewhat appropriately was a commissioner for sick and wounded seamen and a treasurer of Greenwich Hospital, wrote in August, 1699: "I drank the Shooter's Hill waters."

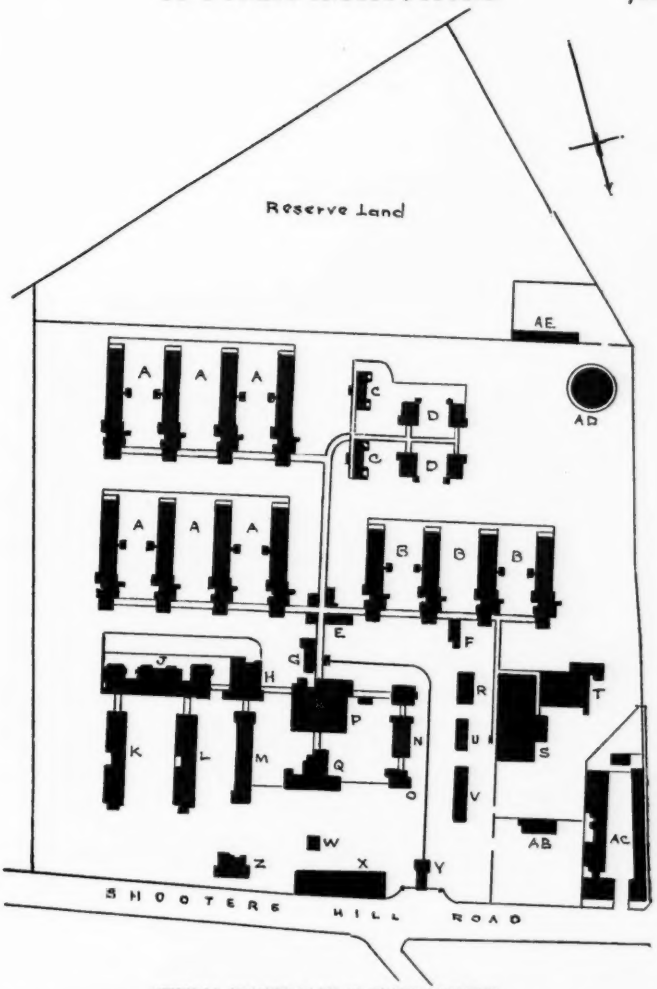
As may be seen from the ground plan which is reproduced opposite, the hospital is practically a village, a small town, symmetrically arranged, and yet possessed of diversity sufficient to present a pleasing general aspect.

The buildings, of red brick throughout, have been designed with especial regard to utility and appropriateness. These are among the first essentials of good architecture, and need by no means be considered inconsistent with true artistic effect.

Although the various pavilions and other buildings are completely isolated, one from the other, they are so admirably linked by covered paths that the visitor is apt to overlook at times the separation which really exists.

Referring to the ground plan, it will be observed that the establishment, which occupies a site nearly thirty acres in extent, contains all the essentials for a complete community. Entering at the porter's lodge, and bearing to the left hand, the steward's house and men's quarters are passed. The residence of the medical superintendent faces the house in which the assistant medical officers and the chaplain make their home, and the block of buildings where the nurses, assistant nurses, and female servants dwell. At the rear of these buildings are the matron's house and sitting-rooms for the nurses, assistant nurses, and female servants.

Administrative offices are situated in the central part of the institution, where also are the dispensary, kitchens, larders, sculleries,



GENERAL GROUND PLAN OF BROOK HOSPITAL.

A Scarlet Fever Pavilions.
B Diphtheria and Enteric Fever Pavilion.
C Single Bed Isolation Wards.
D Four Bed " "
E Scarlet Fever Receiving Ward.
F Diphtheria and Enteric Fever Ward.
G Matron's Office and Sewing Room.
H Housekeeper's Rooms.
J Nurses' Home and Matron's Residence.
K Night Nurses.
L Assistant Day Nurses.
M Female Servants.
N Male "
O Steward's Residence.
P Kitchen Stores.
Q Official Block.
R Medical Education Rooms.
S Laundries.
T Boiler House.
U Diphtheria and Enteric Fever Discharge Ward.
V Scarlet Fever Ward.
W Water Tower.
X Pumping Station.
Y Porter's Lodge.
Z Medical Superintendent's Residence.
AB Mortuary.
AC Ambulance Station.
AD Rainwater Pond.
AE Workshops.

BROOK HOSPITAL, GENERAL VIEW OF BUILDINGS AND POWER HOUSE.

store-rooms, sample-rooms, linen stores, sewing-rooms, etc. These departments practically correspond to the professional chambers, shops, and work rooms found in the outer world, with the important difference, however, that the dispensation of medical advice, of therapeutic agents, of sisterly care and attention, and of nourishing food is unattended by the passing of that desirable commodity, the love of which is stated, on good authority, to be the root of all evil.

Towards the right hand are found departments for medical education, including a lecture-room and laboratory, laundries and the buildings in which are situated the boilers, engines, electric-light plant, engineering workshops, disinfecting apparatus, mortuaries, ambulances, and stables.

At the rear of the hospital buildings there are also smiths', carpenters', painters', and other industrial workshops, rendering the institution practically independent of the outside world, except for the supply of materials.

The general plan provides for the separation of administrative and residential buildings from those in which patients are received. Separate entrance gates are provided for the use of residents, visitors, and those having business at the hospital.

Thus not only are the officials and staff, when not on duty, removed from the usual hospital surroundings, but visitors and other callers need not be exposed to the least danger of infection.

For the reception, treatment, and discharge of patients separate rooms and wards are provided, where diseases are classified, so far as may be conveniently practicable. The main ward pavilions, each two stories in height, with an ample air space under the ground floor, are provided with cooking and all other conveniences necessary, while appliances for regulating supplies of hot water, heat, and light are under ready control by the officials in charge. Each main ward is 120 feet long, 26 feet wide, and 13 feet high, and contains 20 beds. The space allowed per bed is 2,028 cubic feet in scarlet fever cases, and 2,535 cubic feet in cases of enteric fever and diphtheria.

Accommodation exists for the reception of six hundred patients, and, including the staff, the total number of inhabitants, when the institution is full, is nearly 1,000.

In the event of exceptional pressure, temporary wards can be erected on a plot of land included in the grounds, and in this manner a considerable additional number of patients may be received.

Having now obtained a general idea of the arrangement and character of the institution, let us proceed to examine the methods in which heat is applied to minister to the necessities and comforts of its occupants.

As the fountain of all earthly activity is the sun, so, in the minia-

GENERAL VIEW OF BROOK HOSPITAL, SHOOTER'S HILL, KENT, ENGLAND.
The Water Tower is shown on the left.

THE BOILER ROOM AT BROOK HOSPITAL.

ture world under consideration, the main source of heat, light, and mechanical power is derived from a central embodiment. Energy developed in boiler furnaces burning day and night is realised in various forms, and makes its influence felt in every part of the buildings. To this general rule there are two exceptions, inasmuch as gas and fuel are, for some purposes, employed under separate control.

These will be duly considered in their proper places; in the meantime, it is convenient to commence our tour of investigation at the boiler house, which forms part of a block of buildings containing the engines and other important mechanical appliances. The position of the boiler house, therefore, is well chosen, and, if one or two advisable, but comparatively inexpensive, alterations were effected, it would leave little to be desired.

There are three steel boilers of the Lancashire type, each with two flues and fitted with galloway tubes and the usual appliances. The boilers are 30 feet in length by 8 feet in diameter, and are furnished with Henderson's automatic self-cleaning furnaces. Contrary to the practice common in similar installations, no means have been adopted for mechanical stoking, and this operation therefore is performed entirely by manual labour. There is ample room in an adjoining shed for the storage of steam coal, but the space in front of the boilers themselves

might with advantage be extended. The coals deposited there for immediate use are inconveniently near to the boiler fronts, and have to be heaped round the base of a feed-water heater, while the dust, unavoidably raised during stoking, is not calculated to improve a pair of horizontal steam pumps situated in one corner of the stoking department. These disadvantages might readily be obviated by an extension of the boiler-house front and by the removal of the apparatus mentioned to some more suitable position.

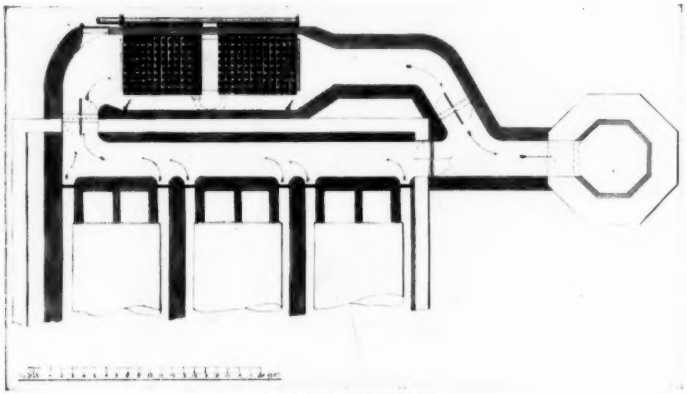
Circumstances such as these serve to emphasise the contention that an architect, however eminent he may be in his own profession, is always well-advised in calling in a properly-qualified engineer to assist in the arrangement and execution of purely engineering work. In this connection it is interesting to note that the metropolitan asylums board "are about to appoint an engineer to advise upon and superintend the various engineering, machinery, drainage, and other works at the several institutions under the control of the board."

The boilers themselves appear to be of excellent construction; they are worked at 125 pounds, pressure per square inch, and are coupled together, so that any one, or all three, may be used as occasion requires. In actual practice two only are used simultaneously the periodical cleaning of each in turn being thus made possible.

Judged by the meaningless, but frequently-adopted, standard, of nominal horse power, each boiler is approximately of about 60 nominal h. p. Of the actual power the writer is unable to speak definitely, but some idea of the power developed may be formed from the consumption of fuel, which at present averages about forty tons per week per boiler, and under times of exceptional pressure has risen to nearly double the quantity. Assuming, therefore, that the boilers possess average evaporative qualities, it will be seen that a very ample margin exists to cover all the variable requirements of the institution.

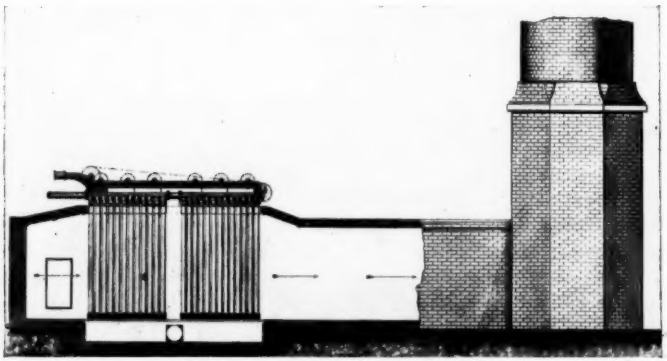
For economising the consumption of fuel various special forms of apparatus have been adopted, one of the most valuable being a Green's Economiser, by the aid of which the feed water may be heated to a high temperature (250° to 300° F.) before entering the boilers, by utilising waste gases from the boiler flues. This apparatus, situated in the horizontal flue connecting the boilers with the chimney shaft, consists essentially of a series of cast-iron tubes (300 in number), each tube being about 4 inches in diameter and 9 feet in length, and all being arranged in sections which are connected by top and bottom boxes, these being again coupled by branch pipes, running lengthwise on opposite sides and outside the brick chamber enclosing the apparatus.

In the present instance feed water is forced into the economiser by

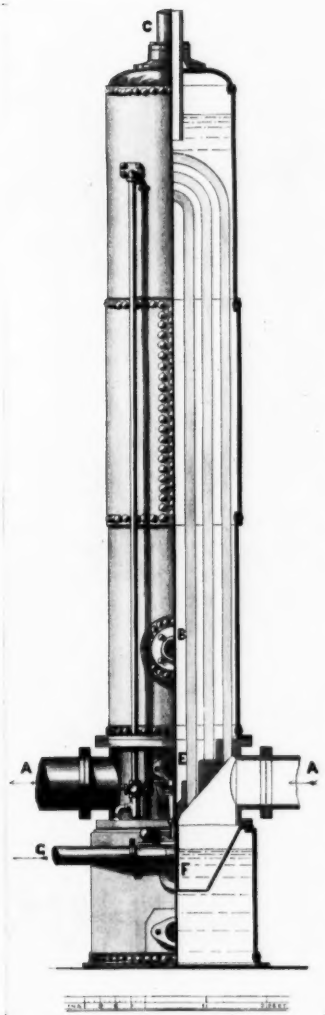


PLAN OF ECONOMISER.

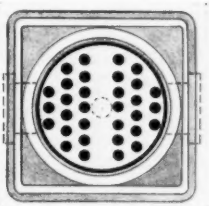
one of the Worthington steam pumps, of which previous incidental mention has been made. The water enters at the lower branch pipe, nearest the exit point of the hot gases of combustion, and emerges at the upper branch pipe, near the point at which the gases enter. As the water tubes are externally exposed to smoke, they would speedily become coated with soot, and consequently less effective for heat transmission, unless provision were made for keeping the surfaces clean. For this purpose each tube is provided with a scraper, which is caused to travel slowly and continuously up and down by the aid of suitable gearing, having an improved form of clutch box for ensuring prompt reversal of the movement at the proper time. Mechanism for working the scrapers is situated on the upper part of the economiser outside



LONGITUDINAL SECTION OF ECONOMISER.



WATER HEATER.



PLAN OF WATER HEATER.

the chamber, motive power being supplied by a small independent engine. Blow-off and safety valves are furnished, and a chamber is constructed at the bottom for the reception of soot removed.

The economy secured by the use of the apparatus varies according to circumstances, but, considering the fact that the products of combustion are, on an average, reduced from 650° F. to about 350° F., it is evident that a very large saving must be effected,—probably 15 per cent. in the case under present consideration.

For the exact determination of the gain in any individual instance the following formula may be used,

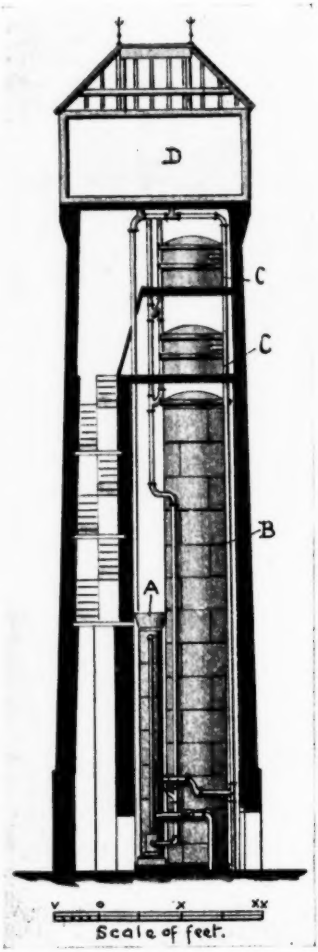
$$G = \frac{100\,(T-t)}{H-t},$$

where G represents the saving of fuel per cent., T the temperature of feed water after heating, t the temperature of feed water before heating, and H the total heat (above 0° F.) of the steam at boiler pressure.

A second arrangement provides for the collection and use of water, condensed in numerous

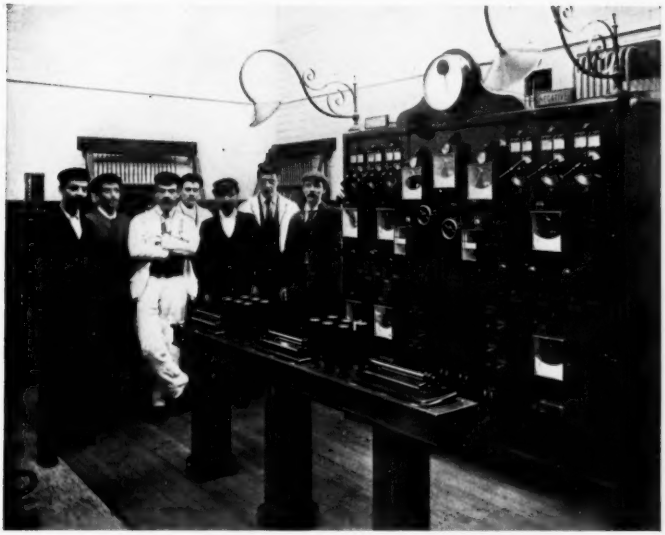
heaters and other appliances all over the hospital buildings. By means of return pipes laid in the subways, such water is delivered into a central reservoir, whence it is pumped to the main feed tank, passing thence through a "Berryman" feed-water heater. This apparatus (already referred to as standing in the stoking space of the boiler house) consists of a vertical boiler-like cylinder about 15 feet in height by 3 feet in diameter. Its internal fittings comprise a series of solid-drawn brass tubes, each length as fixed forming an inverted U, the ends of which are expanded into holes, drilled in a continuous tube plate. Every tube is thus free to expand and contract, independently of the others. Scale does not adhere to the tubes, owing to the difference in expansion between the metal and the scale, and the latter is deposited, together with other impurities, in a siphon chamber forming the base of the apparatus. Exhaust steam from the electric-lighting engines passes into the heater, where practically all of it is condensed in the act of raising the feed water, under pressure, to the boiling-point. The water so condensed is passed through a grease filter, in order that it may be used without injury for boiler-feeding purposes, while an automatic water seal prevents all tendency to back-pressure.

Not only is the heater capable of effecting a saving of about fifteen per cent. in fuel, but the



WATER TOWER, WITH SOFTENING AND FILTERING APPARATUS.

A, Lime Mixing Tower; B, Softening Tower CC, Filters; D, Storage Tank.

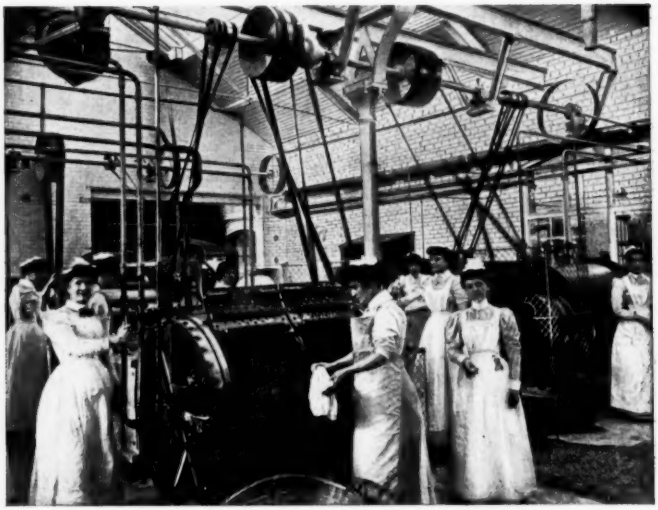


BROOK HOSPITAL; SWITCHBOARD IN THE DYNAMO ROOM.

quality of the water is improved, owing to the liberation of acid and to the deposition of any earthy salts or other impurity. It is obvious that chemical and mechanical processes, such as these, are preferably conducted in a heater, possessing efficient means of removing the products, than in so costly and comparatively inaccessible a vessel as a steam boiler.

By a third method exhaust steam from the main engine is usefully employed, in a similar water-heater. This time the water heated is delivered into a tank, from which it is drawn for laundry and other purposes. The boiler-feed pumps used in conjunction with the apparatus are of the well-known Worthington type.

Such methods of utilising condensed water and exhaust steam, although perhaps not the most perfect which could be devised, are nevertheless of considerable value, and their importance is more fully realised when it is borne in mind that, even in a theoretically perfect engine, reversible in a thermodynamic, and not in the ordinarily understood, sense, the proportion of steam convertible into mechanical power could in no case exceed 26.2 per cent., while the exhaust steam would represent 73.8 per cent. of the total thermal value of the steam used. These figures are arrived at by the well known second law of thermodynamics, which may be stated as follows:



BROOK HOSPITAL; WASHING MACHINERY IN LAUNDRY.

$$P = \frac{T + 461 - (t + 461)}{T + 461},$$

in which P = mechanical power, T = temperature of the boiler, t = temperature of coldest of surrounding objects, and 461 = absolute zero.

Upon consideration of the functions performed in the boiler house and elsewhere, it will be seen that the hospital, as a whole, exemplifies a distillation on a large scale. The boiler house represents a huge still, and the buildings grouped around it correspond to the worm or condensing plant, where aqueous vapour, robbed of its latent heat, reassumes the liquid form and returns to be redistilled. Thus the process continues, hour by hour and day by day, in a never-ending circuit.

From the boilers, steam at a pressure of 125 pounds rises in a main pipe 7½ inches in diameter, which is connected with the main valve of each boiler; and, after passing a steam dryer or "water-catcher," it enters the separate mains by which it is conveyed to perform its various duties. The pressure existing in the mains is proportioned, by means of automatic reducing valves, to the work to be done. To the engines driving the electric lighting plant steam is taken at full pressure; to the laundry and pumping engines, at 60

pounds per square inch. The warming apparatus is supplied with steam at 60 pounds' pressure, the drying chambers are supplied with steam at 30 pounds' pressure, and in the kitchens the pressure is about 5 pounds. The main pipes, in great measure, are laid in subways, so that they may be readily accessible for examination and repair, and their branches extend, in apparently bewildering ramifications, to all parts of the buildings. Altogether, it is estimated that fully one hundred and fifty miles of piping are in use,—a quantity which gives an idea of the magnitude of the operations.

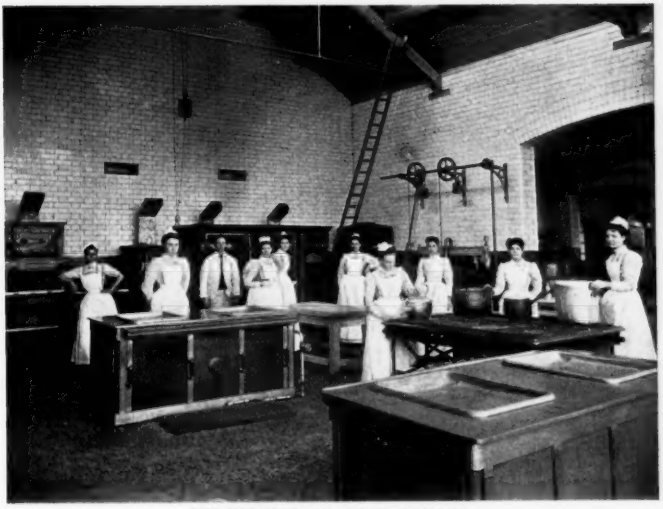
Perhaps one of the most important applications of heat in a hospital for the sick is the provision of means for warming and ventilation. The quantity of heat generated, as the result of a very moderate amount of exercise by a healthy person, amounts, in the course of eight hours, to 2,667 heat units, sufficient to raise 2,667 pounds of water by 1° F., and the heat produced by the chemical action due to respiration averages no less than 6,814 heat units *per diem*, or a quantity sufficient to raise 6,814 pounds of water by 1° F. The sick entirely lack the former source of heat, and enjoy the latter only in a less degree. Therefore artificial means of warmth become necessary, and arrangements must also be provided for ensuring ample supplies of fresh air to remove vapour, exhalations, carbonic acid, and other impurities.

IRONING ROOM AT BROOK HOSPITAL
Showing the electrically-heated ironing apparatus.

INTERIOR OF A WARD, SHOWING HEATING ARRANGEMENT.

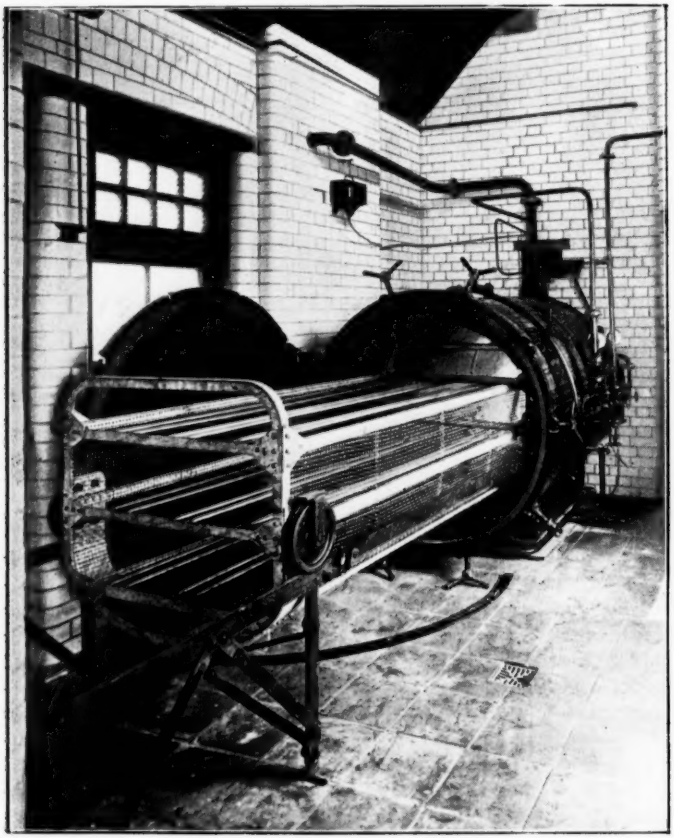
Taking for illustration one of the fever wards, the problem is not only to maintain the air at an equable and pleasant temperature, but also to warm the walls to a sufficient degree. If the air alone were heated to, say, 60° F., its heat would be imparted to the walls and windows, which, in cold weather, would probably be 12° and 18° (respectively) colder than the air.

The patients would, in such a case, suffer from the abstraction of animal heat, given out by radiation to walls at 48° F. and to windows at 41° F., notwithstanding the theoretically comfortable temperature of the air. By raising the air to 75° F. the walls might stand at 60° F., but the atmosphere would then be both oppressive and injurious. Bearing in mind the fact that the normal temperature of the human body is about 98° F., it will be seen that the reception of warmth is not required, and as an actual fact never takes place. The air and walls of a room do not impart heat, and they are warmed simply to prevent their stealing away from the body an undue proportion of heat. Radiant heat has practically no effect on air, although it warms solid objects which stand in the path of its rays. Such objects, when warmed, impart heat to air with which they are in contact, and it is important, therefore, that air entering a room for ventilation should pass over warm surfaces before being dispersed, and that it should be caused to circulate so as to be equally distributed. Arrangements also for warming the walls must on no account be omitted.



THE KITCHENS OF BROOK HOSPITAL.

Various systems, too numerous to mention, are adopted for the attainment of these ends. In the method applied at the Brook Hospital, fresh air is admitted to the wards through the radiators, and the radiators themselves are placed so that they may warm the air near the walls and windows, thus tending to prevent cold downward currents. In the centre of each ward are two handsome stoves with double fireplaces, the flues of which descend under the floor; the top and sides of the stoves are encased in Burmatoff faience. The object of this apparatus is to warm fresh air admitted through channels by contact and to warm the walls by direct radiation. The stoves also aid ventilation, and give a cheerful aspect to the room. Ventilation shafts extending above the top of each pavilion remove vitiated air, the draught being facilitated by internal coils of steam pipes. For the purpose of aiding ventilation in summer, hopper-hung fanlights, opening inwards, are fitted above the windows, and alternative connections are provided for each of the ventilation shafts. In considering the quantity of heat required for warming each ward, account has to be taken of the number of cubic feet of air necessary for each patient. In fever wards it is usual to allow 4,000 cubic feet per hour, and for twenty patients 80,000 cubic feet have, therefore, to be warmed to, say, 60° F. In winter the amount of heat absorbed in the attainment of this object would probably be represented by 40,000 or more heat units per hour.



A STEAM DISINFECTOR.

The mechanical equivalent of this is approximately 30,000,000 foot-pounds,—energy sufficient to raise 13,348 tons one foot.

Large as may appear the quantity of heat necessary for warming the air, it is considerably less than that passing through the windows and filtering through the solid walls as easily as water passes through a sieve. In severe weather the heat dissipated into space by the walls of a single ward probably equals 60,000 heat units per hour. Thus the grand total to be provided by radiators and fires is brought, in

round numbers, to 100,000 units per hour, which, expressed in foot-pounds, is 77,200,000 pounds, or 34,464 tons lifted one foot.

The heat necessary is conveyed in the form of steam by mains passing along subways under the covered paths shewn in the ground-plan. Under the entrance to each pavilion is a chamber containing a water-heater, where the latent heat of steam is given up to water contained in a cylinder, whence it circulates through the radiators and returns to be reheated by fresh accessions of latent heat. The steam, thus robbed of the power by which its molecules are held apart, condenses into water, and in turn is sent back to the central station, to be reconverted into steam. In addition to furnishing the means of heat for radiators, steam is used for the purpose of affording supplies of hot water to the bath rooms, ward kitchen, scullery, etc.

It is, of course, unnecessary to follow the arrangements for heating and ventilating throughout the hospital, as they are all based on a similar system. Speaking generally, both radiators and fires are used for wards, radiators alone for corridors, bath-rooms, etc., and coal fires for sitting rooms. The isolation wards, containing from one to four beds each, are provided with warming and ventilating apparatus, etc., similar to those in the main ward pavilions, except that steam is used for heating in place of hot water.

The quantity of coal burned for purposes other than the steam boilers varies considerably, according to the weather, but the average is probably from 10 to 15 tons per week.

Let us now turn to another most important application of heat, as realised in the form of light.

Closely adjoining the boiler house is the electric-light station, consisting of two rooms, in the first of which are three Belliss high-speed engines and three Siemens dynamos of 50 indicated horse power each. Here also are the switchboards and all necessary appliances for the regulation of the whole system. The second room is occupied entirely by a storage battery of 64 cells by the Electric Power Storage Co., the total capacity of which is 500 ampere-hours.

Every part of the hospital is fitted with electric lights, varying from the tiniest of incandescent lamps to arc lights, each of the latter representing energy equal to one horse power. The incandescent lamps are little short of 5,000 in number, and there are 18 arc lamps. The wires by which the electric current is conveyed from the central station to the hospital wards are carried in two distinct circuits, so as to permit repairs without interference with lighting arrangements.

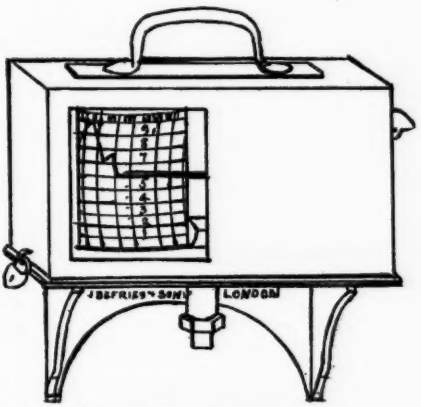
As a means of light gas is very sparingly used, but pipes and a limited number of burners are fitted in the wards for use in the event of serious breakdown to the electric light.

Other purposes for which electricity is employed are the production of vapour in bronchitis kettles, the sterilisation of surgical instruments, and the establishment of a complete system of telephonic communication. There is a central exchange in the office of the superintendent nurse, communicating with the whole of the hospital buildings, with the adjacent ambulance station, and with the offices of the asylum board in London. A central fire-alarm gong is also situated near the centre of the buildings and connected to each separate block by electric wires. This gong is furnished with an indicator, showing from what point the alarm has been received, and with it are connected smaller gongs, sounding in some of the offices and in the men's quarters. The whole of the electrical plant is on a most complete and efficient scale, and was designed and erected under the supervision of Professor Kennedy.

Disinfection, or the destruction of the minute organisms which have been found to constitute the primary cause of all disease, is an operation indispensable in a fever hospital, and is most effectively performed by the aid of steam. The disinfecting chamber, situated at the rear of the boiler house, is divided into two rooms, one for infected, the other for disinfected, articles. Built into the dividing wall is the apparatus, which is that known as the Equifex, using "saturated" as distinguished from the "superheated" steam employed in other types of high-pressure disinfectors. It consists of a steel cylinder somewhat resembling a steam boiler fitted with doors at each end. For preventing loss of heat by radiation the apparatus is protected by non-conductive material and lagged with wood. The articles for treatment, consisting of wearing apparel, bed linen, or mattresses, are placed in a carriage which runs on rails into the apparatus. When the door is closed and securely fastened, air is removed by means of dry saturated steam, which is then caused to fill the machine at a pressure of 10 pounds per square inch. In this the objects remain for a period of about fifteen minutes, which suffices for complete sterilisation. During the process use is made of an exhauster, which, by relieving the pressure, facilitates penetration of the articles, and at the same time re-evaporates moisture condensed and removes any particles of air retained by capillary attraction within the pores of the articles. Drying is effected by means of hot air, heated in its passage over steam pipes, and the articles are removed by the opposite door of the apparatus, once more ready for use. Connected with the machine is an instrument in which a pen actuated by steam pressure marks a diagram or a card attached to a drum rotated by clockwork. In this way the responsible officer may obtain a reliable record of the operations conducted daily, and he is thus in a position

to know whether the proper conditions have been complied with in every case.

In some instances it is desirable to destroy infectious matter, or materials which are not of sufficient value for disinfection in the ordinary manner, and also to burn up refuse generally. For this purpose a furnace is usually provided, so fitted that the heat generated may be utilised for steam-raising or for heating water. At the Brook Hospital there is such a furnace, answering the purposes of destruction, but it has not been thought necessary to make use of the heat produced by combustion, which escapes directly into the chimney shaft.



AUTOMATIC PRESSURE RECORDER.

Immediately adjoining the boiler house is a 16-h.p. nominal, horizontal engine, by Davey Paxman & Co., with disc crank and box section girder frame. This is used chiefly for driving machinery in the laundries, where heat again plays an important part. All the power here used is but another example of the conversion of heat into work, and work again is transformed into heat, which is lost in outer space. Machines available both for cleansing and disinfecting under steam pressure are used in the laundries. Centrifugal power is made to contribute to the process of wringing, while heat is communicated to air by the aid of steam, and caused to traverse drying chambers by fans driven by steam power. Mangling, as ordinarily understood, is here abolished, this operation being effected by machines having steam-heated surfaces and rollers in which the largest articles are mangled or ironed without folds or creases.

Heat is led captive in the service of man in another direction, by assisting in the supply of water for the whole establishment. Adjoining the waterworks pumping station is a water tower standing about 90 feet high and containing a storage tank with a capacity of about 20,000 gallons. At the base of this is a pair of pumping engines, supplied by steam from the main boilers, and through them sometimes as much as 125,000 gallons of water are pumped daily. In lifting the 1,250,000 pounds of water, thus represented, to a height

of 90 feet, nearly 150,000 heat units are converted into work, and, when the liquid finally reaches the level from which it was raised, friction has restored, as heat, the whole energy expended. The interior of the tower is mainly occupied by a water-softening apparatus, capable of treating 60,000 gallons per day of ten hours. Chemical action, another equivalent of heat, is utilised for the purpose of depositing the lime salts whose presence in water is so objectionable and unnecessary.

In the various processes of cooking heat plays a most essential part. Gas ovens and other forms of apparatus heated by gas are largely used in the spacious central kitchens of the hospital, and for many purposes its cleanliness and adaptability renders gas an extremely desirable means of obtaining heat. Steam is also employed in the cooking of meat and vegetables, and in the preparation of soups, broth, beef tea, etc. Steam-heated tables, with dished tops, are used for cutting up joints, and the lower portion of each carving table is enclosed by sliding iron doors, the interior being fitted with perforated shelves. A steam chest at the bottom furnishes heat, so that articles placed inside may be kept warm. The arrangements of the kitchens generally are admirably designed, and in a room close by are stored the dinner wagons, by the aid of which food is distributed to the various buildings.

The water mains are so arranged that water used for drain flushing, etc., is not softened, and all rain water from the roofs is collected in a circular tank, or pond, situated in the lower part of the grounds and capable of holding nearly 200,000 gallons. This water is pumped thence for use in the laundry and elsewhere.

The form of apparatus used is one in which the water is softened under pressure, thus facilitating the delivery of the water after treatment into the tank above. A small reagent pump for the lime is fitted to the main pumps, so that both work in unison. The incoming water passes over a small water-wheel actuating the lime-mixer, and deposition takes place on inclined plates. Carbonate of lime, the most common source of what is termed "temporary" hardness, is insoluble in water, save in the presence of carbonic acid, when the salt becomes an unstable bicarbonate. By adding lime in suitable proportion, carbonic acid is detached from the bicarbonate of lime, and both portions of the carbonate of lime are precipitated. Thus

$$Ca\,CO_3,\,CO_2 + Ca\,(OH)_2 = 2\,Ca\,CO_3 + H_2\,O.$$

For the elimination of "permanent" hardness, represented chiefly by sulphate of lime, it is necessary to add either caustic soda or carbonate of soda, according to the character of the water, and in properly-defined quantities. The equations are thus expressed :

(a) $Ca\,SO_4 + 2\,Na\,OH = Ca\,(OH)_2 + Na_2\,SO_4$
(b) $Ca\,SO_4 + Na_2\,CO_3 = Ca\,CO_2 + Na_2\,SO_4$.

In either case sulphate of soda remains in the water, but, being perfectly soluble, its presence is attended by no inconvenient consequences. For every reason the process is worthy of adoption, as tending to avoid the deposition of scale in steam boilers, to save soap, and to aid the various operations of cooking.

These, then, are the chief applications of heat in a public institution, such as we have been considering, and the whole forms one great example of the innumerable transformations of energy, which originally appearing in the form of the heat of the sun is stored in the fuel only to reappear in heat, light, electricity, and force in motion, even the buildings themselves representing the stored energy which was put into the materials when they were raised to form the structures.

As a concentrated illustration of all the varied forms in which heat may be applied, distributed and transformed, the institution which we have been describing is probably one of the most complete and in many ways not the least interesting.

FIRE-RESISTING CONSTRUCTION.—THE REGULATIONS IN FORCE IN LONDON.

By G. A. T. Middleton.

I.—GENERAL BUILDINGS.

PROBABLY no city in the world has so carefully devised a code of building regulations as has London, or so complete and efficient machinery for seeing that they are complied with. While many other points are dealt with, that of resistance to the spread of fire, if it should break out, and prevention of its occurrence so far as is possible by constructional means, has received a very large share of attention. Some of these regulations may be of purely local importance, and some even may be impossible of adoption in America, quite opposed to certain generally-received opinions; but an enumeration of the most important cannot be without interest.

For instance, it would probably be thought intolerable that the height of a building should be restricted; yet eighty feet, exclusive of two storeys in the roof and of ornamental towers or turrets, is the limit allowed without a special permit, which it is scarcely possible to obtain. Primarily this regulation was made for the sake of light and air to surrounding streets and buildings, but the limit was fixed also largely because a fire occurring in the upper storeys of a high building is excessively difficult to deal with. For this reason it is also provided that any storey constructed in the roof of any domestic building the upper surface of the floor of which storey is more than sixty feet above the street-level shall be of fire-resisting materials throughout, while in any building having a floor of that height there must be provided such means of escape, in case of fire, for the persons dwelling or employed therein as can be reasonably demanded under the circumstances. More than this, every building, such as a shop, which exceeds one thousand square feet in area, and is used partially for trade or manufacture and partially for residence, must have the portion used for residence entirely separated from the portion used for trade by fire-resisting floors, walls, passages, and stairs, except that any doors necessary for communication may be provided in the walls of the staircases and passages. Even more stringent still is the provision that in every building exceeding 2,500 feet in area and containing separate sets of chambers, or offices, or rooms constructed or adapted to be tenanted by different persons, the floors and principal staircases shall be of fire-resisting materials, this regulation affecting almost all erections in flats. Buildings more than 30 feet in

height, and used wholly or in part as dwellings or factories, must also have means of escape provided in the form of means of access to the roof (whence neighbouring roofs may be reached). Unfortunately this applies only to buildings with parapets, which are not compulsory.

The present building regulations—the London building act, 1894—having been devised largely for the express purpose of preventing the spread of fire, it is natural that all external walls, and those separating tenements in different ownerships (known as "party walls"), should be required to be of fire-resisting materials of specified thickness, varying according to an elaborately-laid-down table to correspond with their height and unsupported length. The only timber permitted in external walls is that required for bressummers and storey posts under same, and the frames of doors and windows of shops on the ground storey, unless they be set back four inches at least from the external face. This effectually precludes the use of the picturesque half-timber construction which is so great a favourite in the provinces. Certainly, power of exemption from this clause rests with the county council in the case of certain hard woods, but it is extremely difficult to obtain such exemption.

The complete separation of one building from another by a fireproof party wall is very stringently insisted on. It is not permitted to build any bored timber or wood plate into such wall, whatever its thickness, and, if the ends of any wooden beam or joist bear upon it, they must stop 4½ inches short of the centre; so that there is always a minimum thickness of 9 inches of brickwork or masonry behind any combustible material. If wood plates are needed, they must be carried on corbels.

In order to effect complete separation, these party walls have to be carried above all roofs, and to be corbelled out to separate all eaves gutters; in a building of the warehouse class they must be carried three feet above the roof, and in any other building at least fifteen inches. Where there are dormers or turrets within four feet of the party wall, this must still be carried up as a screen, almost as if they adjoined it. The result of this regulation has been that the party wall, where seen above the roof, as it necessarily must be, has become an architectural feature, the despair of the unskilful, and the opportunity of the skilful, architect.

Roofs, though they must be covered with some incombustible material, such as slate or tile, need not themselves be of fireproof construction. If they were, the necessity for carrying the party wall above them would disappear, and there would be no danger of the roof falling in, should a fire occur.

There are no less than twenty-two subdivisions of the section of

the building act dealing with chimneys and flues, providing carefully for safety, yet allowing all reasonable latitude. Chimneys are allowed, for instance, to be built on iron girders, if properly supported, or on corbels of any incombustible material, if they do not project from the wall more than the thickness of the wall directly below the corbel. If provided with proper soot doors of not less than forty square inches, the flues may be constructed at any angle; if without them, the angle must be not less than 45° with the horizon. All angles must be rounded. Soot doors must be kept at least fifteen inches from all woodwork.

In ordinary circumstances the brickwork of a flue need be only half a brick (4½ inches) thick; but, if it is to be used where considerable heat is to be expected, as for any furnace, or even a close fire used for purposes of trade, or for the cooking range of any hotel, tavern, or eating-house, the thickness must be at least 8½ inches, from the floor on which this furnace may rest up to the ceiling of the room next above the same. Doubtless it has been difficult to define the line of demarcation, but it seems as if many boarding-houses, and even the larger private houses, often have as much heat generated in their kitchen ranges as is generated in hotels. A minimum thickness of 8½ inches is also insisted upon at the back of a fireplace in a party wall (though only up to 12 inches above the mantel) and on the upper side of all flues inclined at less than 45° with the horizon.

The inside of every flue must be forged, or else lined with stoneware piping, as must also the outside where passing any floor or roof or behind or against any woodwork—a somewhat unnecessary rule where the flue passes through a fireproof floor, but generally a salutary one, in view of the great number of fires which have been traced to the igniting of woodwork near an overheated flue.

Incombustible hearths must be provided to all chimney openings, at least 6 inches wider on the longer side than the opening, and projecting 18 inches in front, carried entirely on incombustible supports. No timber or woodwork is permitted to be placed underneath the hearth within ten inches of its upper surface.

Similarly, no woodwork may be inserted in any wall or chimney breast within 12 inches of the inside of the flue or chimney opening.

Furnace chimney shafts are just as carefully regulated as are those for ordinary fires, but rather from the standpoint of stability than from that of fire prevention, as they are usually detached.

Pipes conveying smoke or other products of combustion must be fixed at least 9 inches from combustible materials; pipes conveying heated air or steam, at least 6 inches; pipes conveying hot water, at least 3 inches. This rule does not apply, however, if the hot water

or steam be at low pressure, this being defined as being provided with a free blow-off.

Wooden structures more than 12 feet in height are allowed to be erected only under special license, difficult to obtain; except hoardings enclosing vacant lands, and temporary structures erected by a builder for use during the construction or alteration of a building.

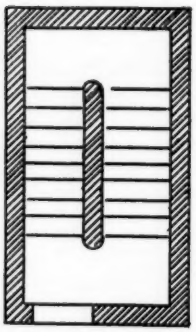
II.—PLACES OF ENTERTAINMENT.

If, however, the precautions against fire, in the case of ordinary dwellings, are stringent to the limit of expediency, much more so are they in the case of places of entertainment, in the interests of the large crowds which collect and whose lives would be jeopardised by a panic. It is the panic, in fact, caused by a fire alarm, rather than the occurrence of a fire itself, which is the most dreaded; consequently a great deal of attention is given in the regulations to the provision of adequate means of escape, and to localising any fire which may occur.

To obtain a perfectly open site in crowded London is exceedingly difficult, and large theatres in the heart of "town," and small suburban concert halls, have alike to be contented with something less ideal; but, as all classes of buildings devoted to entertainments are treated under the same regulations, all are required to have at least one half of the length of the boundaries of the site abutting upon public thoroughfares, the principal one of which must be at least 40 feet wide, and the others at least 30 feet wide, if carriage-ways, and 20 feet wide, if foot-ways. There must be at least two of these thoroughfares; for there must be at least two exits, not leading into the same thoroughfare or way, to every tier or floor of the premises; and, if any tier or floor is divided into two parts, then each part must have its two separate exits, and these exits must be so arranged as to offer a ready means of egress from both sides of each tier or floor direct to the outer thoroughfare. Were this provision an absolutely rigid one, however, it would do away entirely with the vestibule, or *foyer*, so general and beautiful a feature in all large theatre plans; so this is permitted as one of these means of egress. But only three tiers, or floors, at most, may communicate therewith, and its width must be one third greater than the combined width of all the doorways opening into it, which operates not so much to the increasing of the width of the vestibule as to the cramping of that of the doorways.

While two exits must be provided from each tier or floor, however, only one of these may also be used as an entrance.

With this careful provision as to number of exits, it becomes of the first importance that their size and construction should also be regulated. Consequently, every staircase, lobby, or passage for use



TYPICAL STAIRWAY.

of not more than 400 persons must be 4 feet 6 inches wide, this being increased by 6 inches for every additional 100 persons, until a maximum width of 9 feet is reached. The stairs must be of solid square steps, with at least 11-inch treads and at most 6-inch rises, in straight flights of not less than 3 and not more than 12 steps each, with treads of uniform width and the ends of steps pinned into brick walls at both ends. No staircase may have more than two flights of 12 steps each without a turn, and the several flights must all be supported and enclosed upon all sides by brick walls at least 9 inches thick, carried up from the foundations, while all landings must be at least 6 inches thick and square on plan. Thus the open staircase is an impossibility, the box form being so clearly suggested as to be in almost universal use,—the stairs, that is, being enclosed within a brick rectangle on plan, with a brick partition wall longitudinally down the middle, to separate and give support to the different flights. There must be a fireproof roof to the stairs, so that, once on the staircase, the people are safe; the short straight flights serve to break a rush, and reduce the danger from falling and crushing to a minimum.

The same fire-resisting character is required, so far as possible, in the whole building. Dressing-rooms must be of fire-resisting materials, in a block separated from the main buildings by party walls, with only the least possible of openings for communication, and provided with a separate exit; and, where there is a stage with proscenium, the proscenium wall must be of brick, at least 13 inches thick, and have only three small openings besides the proscenium opening, each closed with an iron door, so hung as to close of itself without a spring. All decorations round the proscenium must be of fire-resisting material, and the opening must be fitted with a fire resisting screen to be used as a drop-curtain.

All workshops and painting-rooms, like the dressing-rooms, must be distinct, and of fireproof construction, all communication with the main building being through self-closing iron doors; and, of course, all limelight tanks and engine and boiler rooms must be similarly treated, as must all scene docks and stores.

All constructional ironwork throughout must be cased in fire-resisting material.

When gas is used as the illuminant, as is still usual, three separate meters and services must be provided,—for stage, auditorium, and stairways respectively,—the meters being placed in ventilated fire-

proof chambers. The piping must be of brass or iron, the brackets without joints, and, when within reach of the audience, secret taps must be used, to prevent the lights being turned out for mischief.

Upon the stage the regulations are equally complete, for protection of footlights, wing lights, battens, and movable lights, so that no inflammable dresses or scenery may reach them; but strong flexible tubing is permitted of necessity to the movable lights.

For reasons difficult to explain much more fear is shown of electric lighting than of gas, and it is permitted only on condition that it is certified to be in good order, by a competent electrical engineer, every six months,—a great deterrent in the case of small suburban concert rooms, and generally thought to be unnecessary and vexatious.

Again, as with gas, three circuits must be provided; but in this case, though the stage is separately served, the auditorium and stairways must have half their lights on one circuit and half on another, so as to remain lit even if one circuit be cut off. No sub-circuit may carry more than 65 ampères, and each sub-circuit must start from a distributing board.

Conductors conveying currents of high electro-motive force inside buildings must be specially insulated and cased in a fireproof casing, with terminals at least 12 inches apart and carefully protected from risk of contact.

Generally speaking, the regulations affecting conductors, switches, and cut-outs are very closely detailed, with a view to preventing all possibility of dangerous short-circuiting, or spark, or the falling of fused metal; while arc lamps are practically prohibited, and generating plant has to be kept distinct, the sufficient ventilation of any room containing a gas engine being particularly insisted upon, as is also the ventilation of all rooms containing primary or secondary batteries.

In addition to gas or electric lighting, a few oil or candle lamps have to be kept continuously burning, but mineral oil may not be used.

As protection in the event of a fire, all places of entertainment calculated to accommodate one thousand persons or more have to be provided with fire hydrants supplied either from a water main or from two large cisterns, each containing at least 250 gallons of water per hundred persons of the audience; while theatres are obliged to have direct telephonic communication with the nearest fire brigade station,—a notable thing in London, where the telephone is very little used.

THE HIGH-SPEED STEAM YACHT AS A FACTOR IN TORPEDO-BOAT DESIGN.

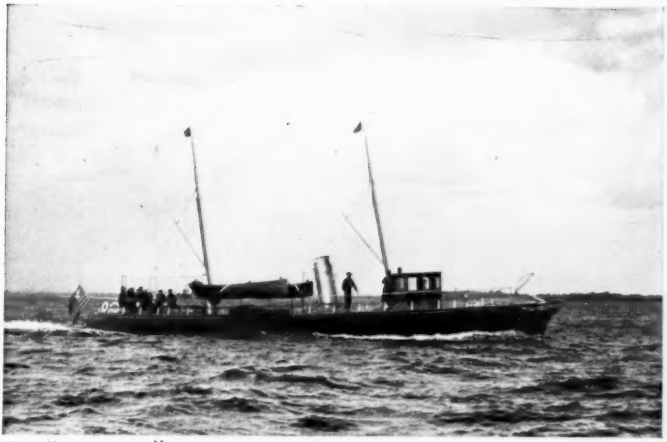
By W. P. Stephens.

II.

THE year following the Stiletto's advent, her builders sent to New York, on the occasion of the annual regatta in June, another notable craft, the open launch, Henrietta. She was 48 feet over all, 46 feet 7 inches lwl, 7 feet 6 inches beam, and 3 feet draft, with a triple-expansion engine 4 and 6½ and 10 inches by 8 inches. She too showed a very high speed in her ordinary running about New York, and made a record a little later in the American Yacht Club regatta, when she covered the Larchmont-New London course in 5 hours, 22 minutes, and 14 seconds, being second to Atalanta out of a fleet of steam yachts very much larger than herself.

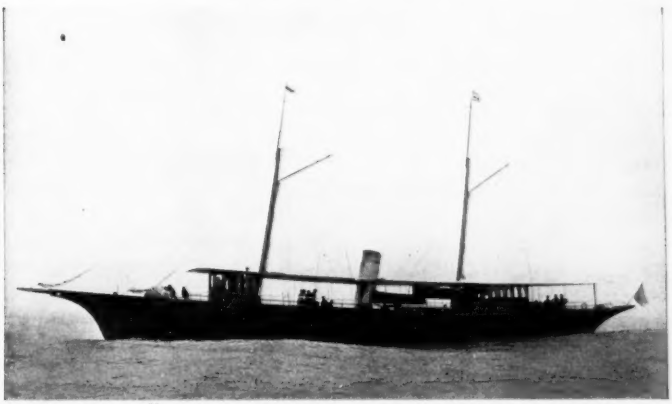
The owner of the Henrietta, to whose order she was built, was the late Norman L. Munro, of New York, an enthusiast in the development of the high-speed steam yacht. He had already built the Norma, a large-decked steam yacht, from which much was expected, but which proved a failure. The success of the Henrietta led to the placing of an order with the Herreshoffs for a larger craft, and in 1887 the Now Then was launched at Bristol. She was of the regular wooden construction of the firm, 86 feet 4 inches over all, 81 feet 9 inches lwl, 10 feet beam, 5 feet 7 inches depth of hold, and 3 feet 2 inches draft, with triple-expansion engines 7½, 12, and 19 inches by 10½ inches, and a coil boiler 6 feet 3 inches by 5 feet 3 inches. Though a fast boat, the Now Then by no means came up to the standard of the Stiletto and Henrietta, and failed to meet the expectations of her owner. The following year she was returned to her builders in partial payment for a new and still larger yacht, from which a much higher speed was expected. The Say When, as she was named by Mr. Munro, was 138 feet over all, 115 feet lwl, 14 feet beam, and 4 feet 6 inches draft,—an elaborately-built craft, with mahogany planking and a complete outfit of the most improved Herreshoff machinery. The Now Then was of the decked launch type, with the stern cut away on deck and broadening out just at the surface of the water, but the Say When was of the conventional steam-yacht type, with longer clipper stem and the usual yacht counter. Though a serviceable boat, she too failed to realize the speed expected of her.

The building, in successive years, of the Stiletto, Henrietta, Now Then, and Say When served to attract the attention of yachtsmen



THE "NOW THEN," DESIGNED AND BUILT BY HERRESHOFF MFG. CO., BRISTOL, R. I.

and the general public to this type of yacht, and to awaken a very deep interest in it. While the Now Then was under construction, rumors were current of a new craft, the work of an unknown designer, that might be expected to take a high place in the class. During the summer of 1887 these rumors took definite form in the advent in eastern waters of the Buzz. This yacht, both hull and machinery, was designed and largely built by Mr. C. D. Mosher, of Amesbury, Mass., a young man who for some time had been engaged in the



THE "SAY WHEN," DESIGNED AND BUILT BY HERRESHOFF MFG. CO., BRISTOL, R. I.

THE BUZZ, DESIGNED AND BUILT BY C. D. MOSHER, NEW YORK.

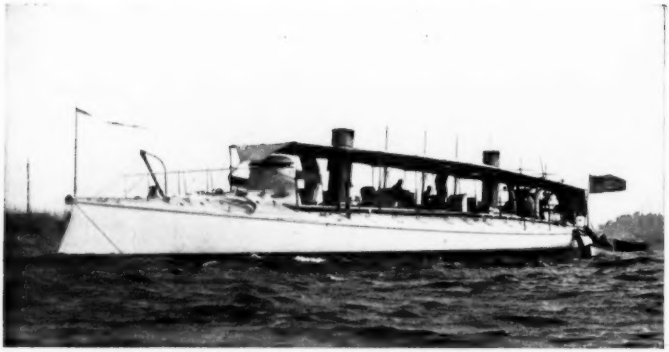
study of the problem of high speed by methods of his own, making numerous experiments with models, launches, boilers, and engines. The result of a great deal of study and preparatory experiment was a cabin launch 50 feet over all, with a ram bow, 6 feet 6 inches beam, 3 feet depth of hold, and 1 foot 4 inches draft aft. The hull was of light construction, with oak frames 1 by 1½ inches, spaced 8 inches. The displacement was 3.50 tons. The double-cylinder engines were 8 by 8 inches, with steel bar frame, the piston valves being 3 inches in diameter. The locomotive boiler was of the torpedo-boat type, 5 feet long and 2 feet 8 inches in diameter, with 250 brass tubes, the heating surface being 357 square feet. A Sturtevant blower, connected to the main shaft, discharged into a closed ashpit. The Buzz was speeded over short courses a great many times, in the east, on the Merrimac river and about Boston, and also on Long Island sound, covering the measured mile in 2 minutes 30 seconds, her highest record being 2 minutes 8 seconds. She was finally sold to Messrs. McBride, of Philadelphia, who used her on the Delaware river, under the new name of Yankee Doodle. In 1891 she was burned while at anchor; the hull sank, but was raised later, and the machinery was used in a new and larger hull, Yankee Doodle II. As a result of the success of the Buzz, Mr. Munro placed an order with Mr. Mosher for a larger boat, the hull of which was built by W. K. Pryor, of South Boston, while the engines were built directly under the designer's supervision. This new craft, the Norwood, was not completed until 1890, making her appearance in New York in mid-summer. She was 63 feet over all, 7 feet 3 inches beam, and 4 feet extreme draft, with open cockpits forward and abaft the engine space, each 10 feet long. She was decked forward for a length of 12 feet and aft for a length of

10 feet, with water-tight compartments under the decks. Her triple-expansion engine had cylinders 9, 14½, and 22 inches by 9 inches, indicating 450 h. p. when making about 560 turns. There were independent air and feed pumps, blower engine, and an inboard surface condenser. The boiler was of the modern water-tube type, designed by Mr. Mosher, with 800 square feet of heating surface, the working pressure being 275 pounds. The Norwood marked a distinct advance, in design and construction, over previous efforts, departing widely from the old type of launch hull, and indicating the new line on which advances have been made. Above water she

THE VAMOOSE IN THE HERRESHOFF SHOPS, BRISTOL, R. I.
The bow of the Penguin is seen in the foreground.

showed a plumb stem and straight sheer, with sides nearly vertical, all the level lines, from deck to water, being round and full, with the greatest breadth well aft and carried out with little diminution to the extreme stern. The floor was nearly flat, and carried well fore and aft, with a short round to meet the sides. At its after end, over the propeller, it was concave, similar in shape to the bowl of a spoon, the edges of this spoonlike portion joining the sides at a sharp angle. The construction included a system of light steel channel beams as keelsons, steel frames, and mahogany planking in two skins, ⅜-inch inside and ⅝-inch outside, with canvas between. In her many runs about New York, the Norwood has shown a speed of more than 30 miles.

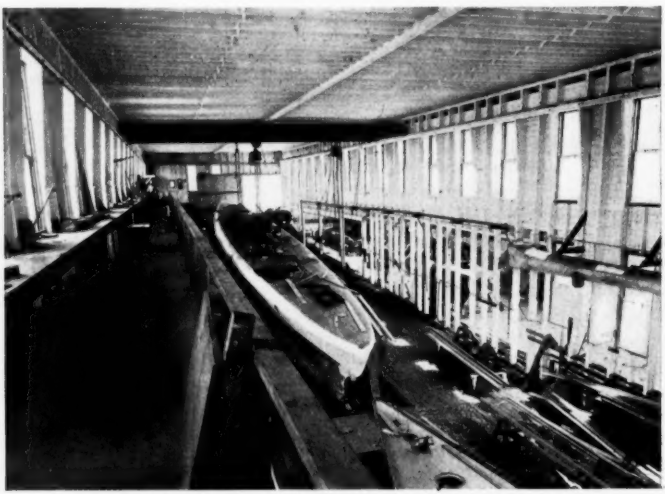
In 1890 the Herreshoff Manufacturing Co. completed the second



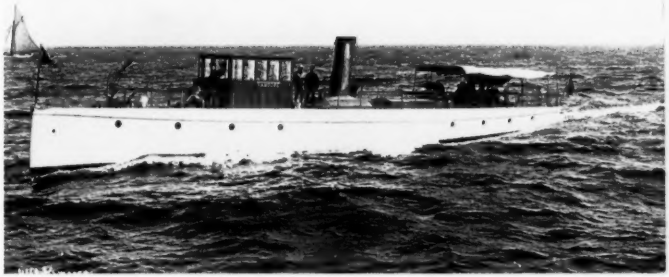
U. S. TORPEDO BOAT CUSHING. HERRESHOFF MFG. CO., BRISTOL, R. I.

torpedo boat built for the United States government, the Cushing, built of galvanized steel, 137 feet 6 inches over all, and of the general type then built in large numbers by the British and continental governments. The Herreshoff type of coil boiler was discarded for the Thornycroft type of water-tube boiler, and quadruple-expansion engines were used.

In the summer of 1891 two steam yachts were launched at the Herreshoff works, the Javelin and the Vamoose. Both were of the



THE VAMOOSE IN THE HERRESHOFF SHOPS, BRISTOL, R. I.



THE VAMOOSE, DESIGNED AND BUILT BY HERRESHOFF MFG. CO., BRISTOL, R. I.

full-decked type, with accommodations for cruising, but they were intended for a far higher speed than had thus far been attained in this type of craft. The Javelin, ordered by Mr. E. D. Morgan, was 97 feet 10 inches over all, 94 feet 6 inches lwl, 10 feet 3 inches beam, 6 feet 7 inches depth of hold, and 5 feet draft, with triple-expansion engines 9, 14, and 22½ inches by 12 inches, and a Thornycroft boiler. The Vamoose, ordered by W. R. Hearst, of San Francisco, was 112 feet over all, 108 feet lwl, 12 feet 4 inches beam, 9 feet 6 inches depth of hold, and 5 feet draft, with quadruple-expansion engines, one cylinder 11¼ inches, one 16 inches, and three 22½ inches by 15 inches stroke. With 400 turns the i. h. p. was 800. The two yachts were of similar model and construction, with a rounder section and more deadrise than the Norwood, and the after body fined away in the usual manner. The Javelin failed to realize the expectations of her owner, and did not show remarkable speed. The Vamoose was more successful. She has been in continual service for a number of years, and has a record of 22.6 miles, over the American Yacht Club course off Milton Point.

The first reputation of the Herreshoffs as builders of fast yachts was made in sailing craft, prior to the seventies. For nearly twenty years, however, their main efforts were directed to the improvement of the steam yacht, other designers meanwhile becoming prominent in the sailing division. At the same time that the Javelin and the Vamoose were being built, the firm had on the stocks a sailing yacht to the order of Mr. E. D. Morgan for the then new 46-foot class. Of the many fast vessels associated with the name of Herreshoff, there is

THE FEISEEN, DESIGNED BY C. D. MOSHER, NEW YORK.

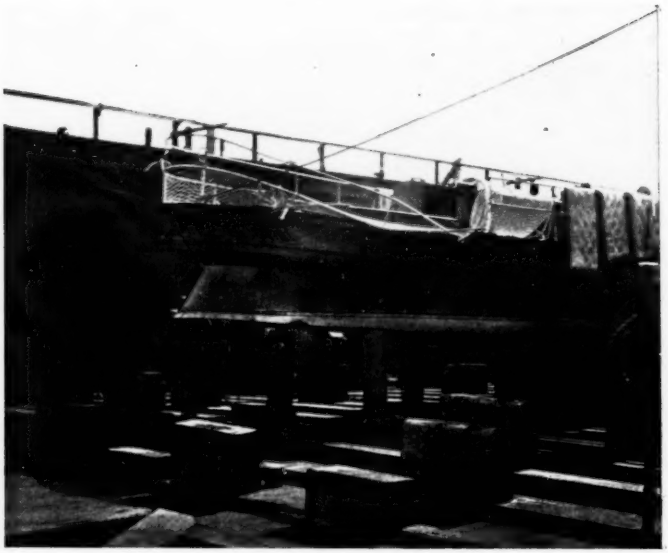
none, perhaps, more famous than this craft, Gloriana. She was remarkable not only for her superiority to all others of her class, but as the embodiment of certain new principles of designing which since have been universally accepted by designers. Her wonderful success turned the work of the Bristol shops into a new channel. She was followed by a still greater novelty, the fin-keel Dilemma, in the fall of 1891, by Wasp in 1892, Navahoe and Vigilant in 1893, Defender in 1895, and a fleet of smaller craft that have been successful abroad as well as in home waters. With the building of the Cushing and Gloriana the work of the Herreshoffs took a new direction. While still building steam yachts of the cruising type, they have made no attempt at exceptionally-high-speed yachts since the Vamoose, their efforts being concentrated on sailing yachts and on torpedo boats.

After the success of the Norwood, Mr. Mosher came to New York and designed two larger yachts, the Feiseen and the Nada, which were built by Wood & Son, at City Island, New York, in 1893. The Feiseen, built for W. B. Cogswell, of Syracuse, N. Y., was 85 feet over all and the same on the waterline, with 9 feet 8 inches beam and 3 feet 6 inches draft, with engines 9½, 13½, 18, and 24 inches by 10 inches, developing 600 i. h. p. when making 600 turns, the Mosher boiler working at 250 pounds. The Nada, built for Mr. Hugh J. Baxter, was 85 feet 9 inches long, 11 feet 6 inches beam, and 3 feet 4 inches draft, with cylinders 10, 14, and 20 inches by 10 inches. The two were similar in construction to the Norwood, double-skin composite, and both were of the decked cruising type, but intended for different purposes. The Feiseen was expected to realize an exceptionally high speed, as an experimental craft. The

Nada was intended for the regular service of her owner, carrying him to and from the city at a higher speed than was attained by other yachts in the same service on the Sound and the Hudson river. Both proved successful, the Feiseen making at times more than 31 miles. They boasted of comfortable cabins, galley, and the usual accommodations of a cruising yacht, the Nada, in particular, being very elaborately fitted below. At the time of the troubles in Brazil, 1893, both the Feiseen and the Javelin were sold to that country, being refitted as torpedo boats in New York, with conning towers and armament, and shipped to Rio Janeiro by steamer.

The highest speed thus far attained by a steam vessel was achieved in the last effort of Mr. Mosher, the steam yacht Ellide, built at Nyack, by Samuel Ayers, for E. Burgess Warren, of Philadelphia, and launched in April, 1897. The Ellide is of the open cockpit type, designed exclusively for high-speed experiment. She is 80 feet over all and on the waterline, 8 feet 4 inches beam, and 3 feet 6 inches draft. From the knife-edge of her bronze cutwater her sides swell out in a slightly convex wedge, with beautifully-curved lines until the midship section is reached, the sides from there aft being practically parallel and vertical. The bottom is nearly flat amidships, with a short round joining it to the sides, the sections assuming more of a deep U shape as they near the bow. The after portion of the bottom, forward of and over the wheel, is of the spoon shape already mentioned. The stern is of a peculiar form, best described perhaps by the simile of one half of an hour-glass divided by a vertical plane through its longitudinal axis. The outline on deck is a semi-circle, as is that around the spoon portion of the bottom, the sides between deck and bottom being constricted, like the neck of the glass. The hull is of composite construction,—a very light frame of steel keel-

THE NADA, DESIGNED BY C. D. MOSHER, NEW YORK.



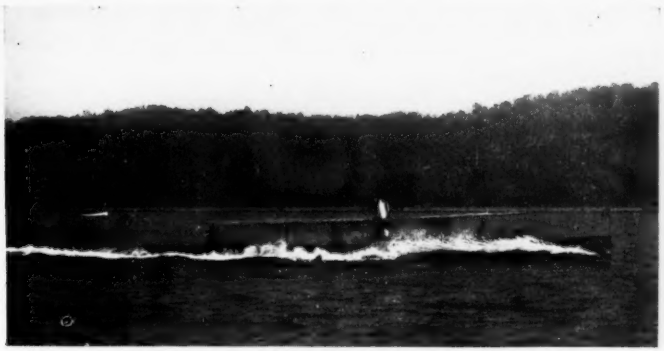
THE FEISEEN; DESIGNED BY C. D. MOSHER, NEW YORK.
View in dry dock, showing typical stern and middle body of the Mosher type.

sons and ribs strongly braced, with a double skin of mahogany fastened with bronze bolts. The engines were specially designed by Mr. Mosher and constructed under his supervision; the cylinders are 9, 13, 18, and 24 inches by 10 inches. The boiler is 6 by 8 by 4 feet 6 inches, with 1,228 tubes of solid-drawn steel. Six independent engines are employed for the circulating pump, feed pumps, blower, etc. The speed trials were made last summer under such conditions as to secure absolute and reliable results, a course of one mile being laid off by officers of the United States coast survey, and the trials being witnessed by officers of the navy. The yacht made a speed of 37.89 miles, covering the mile in 1 minute 35 seconds.

The purpose of such craft as the Stiletto, Norwood, Feiseen, and Ellide is almost entirely experimental, to pave the way for improvements more directly utilitarian. It is not to be expected that the speed attained will be equalled for some time to come in vessels of greater size and of different type. The highest results thus far in the large sea-going cruiser type have been attained by the Fairfield Shipbuilding and Engineering Co., of Glasgow, in the steam yacht Giralda, recently sold to the Spanish government for conversion to war

purposes. This yacht, designed by her builders, was launched in 1894; she is 312 feet over all, 275 feet lwl, 35 feet 1½ inches beam, 19 feet depth of hold, and 1,664 tons, Thames measurement. As a pleasure yacht, she is elegantly fitted throughout, nothing being sacrificed in this respect. Her power includes two sets of triple-expansion engines, each with one 25-inch cylinder, one 40-inch, and two 45-inch, by 27 inches stroke, driving twin screws. In a race at Nice, on April 11, 1895, the Giralda covered a course of 26.5 miles in 1 hour, 8 minutes, and 22 seconds,—a speed of 23.25 knots.

In this brief summary of the parallel development of the yacht and the war vessel, only the more typical craft have been mentioned, and no attempt has been made to do full justice to all who have taken part



THE ELLIDE; DESIGNED BY C. D. MOSHER, NEW YORK.
Photographed when making 37.89 miles an hour.

in the work. The outline of the subject is, however, sufficiently complete to demonstrate several important points. With the successful experiment of the Miranda, in 1871, the British designers practically abandoned the high-speed yacht as an intermediate, and took up directly the problem of the torpedo boat, and in 1885 the torpedo-boat destroyer. The liberal support accorded by the British government and the continental powers made it possible for Messrs. Yarrow, Thornycroft, Normand, and others to carry out elaborate and costly experiments year after year. These favorable conditions not only made it unnecessary to experiment through the steam yacht, but, by concentrating all efforts on the torpedo boat, tended to hinder the other line of yacht development. The requirements of British yachtsmen have been, in the main, seaworthiness and accommodation rather than speed, and, with the attainment in the steam fleet of a high degree of perfection in the first two, there has been little de-

mand for more than a good cruising speed, maintained regularly in continued service. While the Giralda is an exceptional vessel, the past three years have witnessed a material increase in the speed of the larger yachts, as in the Watson craft,—Mayflower, Varuna, Margarita, and Nahma.

The great fleets of torpedo vessels in the navy lists of all European powers to-day, and the prominence accorded to this division in the naval estimates, show that there is ample inducement to the designers and builders to continue the work of improvement in the direct line which has produced such results. The condition of affairs in the United States has been in the past, and must continue to be, materially different. Though in a measure committed to the work of developing torpedo warfare in all of its branches, the United States did nothing after the civil war, and has consistently held to the same policy almost to the present day. That any progress has been made, and that the nation to-day is not entirely dependent upon foreign designers and builders, is due solely to a small number of yachtsmen who have furnished the material aid, and those American designers who have furnished the brains for experiment. The past four months have witnessed an awakening that is likely to be permanent; face to face with war, the whole nation has been forced to realize the vital importance of a strong defensive navy, and the danger to which it has been long exposed by the policy of a wasteful economy. There is little doubt that, as soon as the present war is happily ended, the work of naval construction will be taken up as never before. At the same time there is much to do, in every class, from the battleship to the smallest torpedo scout, and the experience of the past shows that a portion of this work can be better done by private enterprise than by government aid alone. The problem of extreme high speed, the precursor to a general increase of practicable working speed in all classes of vessels, requires for its successful solution the highest efforts of the designer, untrammeled by those limitations and restrictions which are almost inevitable when he is called on to deal with government bureaus.

THE GOLD RESOURCES OF INDIA.

By William King and Theo. W. Hughes Hughes.

INDIA has for centuries been so looked to as a land of potentialities in mineral development that few more difficult, or even thankless, tasks have fallen to the lot of those officially connected with its geological examination than that of having to qualify, if not dispute altogether, the so frequently exaggerated accounts of renewed prospecting in regions well known as barren, or of reported rich discoveries in tracts supposed to be new; though there is, no doubt, room enough yet for the prospector, be he honest and capable, or the assumed and assertive practical adventurer, to explore the country lying between the more restricted and widely-separated regions of known geological formations of mineral value in the million and a half square miles of the empire.

It is no easy matter, either, to reconcile the aspirations of those interested in its material welfare to the seemingly poor and really scattered distribution of these formations. It seems a hard thing that all South India can as yet look to only one corner coal field, with its stores of magnificent iron ore beyond payable reach of fuel, whereas Bengal and the central provinces have the Indian carboniferous stores lavishly distributed; and it is incomprehensible to most people that the Punjab oil flows should be so much poorer than those of Burma, and that a fancied resemblance between the two countries should not warrant favourable comparison with the Baku wells on the Caspian; while perhaps no problem is oftener questioned than why gold should be so fitfully developed through the belts of the Indian metalliferous series occurring in the Madras presidency, the central provinces, Bengal, or Burma.

So it is, however, in the matter of distribution and extent, while the remarkable feature in the progress of these explorations in India is that there have been no particularly new discoveries outside the various tracts known for a very long time. It is the localization of them, their extent, and more particularly their development, which have been the work of geologists and mining experts for the last forty years. And this has been perhaps most strikingly shown in the very successful opening of the Mysore auriferous tract during the last seventeen years.

The auriferous character of this place and of all the other known places in India was founded on the occurrence of desultory, but apparently remunerative, washings of but small account, or upon mani-

festly ancient underground workings having distinct evidences, on the surface, of crushing and other manipulation of the ore matrix, where also washing was still carried on in the adjacent shallow streams or in the material from the old dumps. In no case, however, was there any knowledge or tradition of the old miners; nor was much known of the ore lodes, until geological surveying was instituted, when these various tracts were catalogued into ten districts of the Bengal presidency, three districts of Bombay, thirteen districts and smaller divisions of the central provinces, seven Madras districts, ten districts and divisions of the Punjab, in the eastern Godavari part of the nizam's dominions, in the north-west provinces, in Assam and Burma, and away north-westward into Afghanistan.

It may be said at once, of the gold-washing in all this wide distribution of more or less auriferous surface-material on or adjacent to presumably gold-bearing rocks, that it has never been found to pay any better than the desultory operations of the few washers who generally assemble or camp out at the recognized washing sites during the off-work seasons of the year. Several attempts at larger operations have been made by Europeans, particularly in Assam, but always without corresponding out-turn; and the only conclusion seems to be that those washing sites which appear the most promising are merely concentrations from tributary tracts only sparsely seamed by auriferous reefs, some of which may be found to repay quicker and larger concentration than that resulting from ordinary atmospheric denudation. In many cases of washing near the sites of old mining operations it is really the *débris* from those mines, rather than the denuded materials of the reefs themselves, which are sifted by the washers.

On the other hand, the manifest inference from the ancient underground workings, looking at their extent and ramifications among quartz reefs and their leaders, is that here at least had been some more organized and continuous system of working, which gave a required out-turn, even though they were in all probability carried on under forced labour,—an inference which has been fully justified in Mysore. Thus it seems tolerably certain that the gold production of India is almost entirely dependent on the extraction of the metal from its original condition of lode-association rather than on any secondary or derived form of concentration.

Taking this view, the auriferous areas can be more definitely studied in peninsular India,—that is, all the country south of the great plain-belt of the Indo Gangetic alluvium. Outside this, or northward, is the extra-peninsular region, in which, with the exception of Burma, gold appears to be poorly distributed. In peninsular India the gold areas are generally embraced within the range of the transition series,

a few only, among them that of Wainad, being in the more prevailing Crystalline, or, generally, Gneissic, series. The more important indications are in a well-recognised development of the transitions originally distinguished in the district of Dharwar, in the Bombay presidency, as the Dharwar Series, by our colleague, Mr. R. Bruce Foote, and consequently shown by him to be the auriferous series of India *par excellence*. The gold fields of lesser note, or of as yet doubtful character, occur in belts of sub-metamorphic rocks, which certainly seem to be also of the Dharwar series.

Leaving the Wainad country for separate consideration, the main fields of the Dharwars are the Mysore and Dharwar belts in South India, the Raichoor Doabs tract in Hyderabad (Deccan), several belts in the central provinces area, and others in the Bengal tract in Chota-Nagpore. Ancient workings are more or less recognisable in all; and, seeing the marvellous success of the Mysore development only after very persevering and prolonged exploration, the poorest looking among the others should not be rashly condemned until fully tested. Nor ought the similarly-altered or sub-metamorphic and metalliferous rocks constituting the Aravali hill-ranges in Rajputanana and central India to be left unexplored.

So far, however, the true quality of the recognised Dharwar tracts has been completely proven only in the Mysore area, usually called the Kolar Gold Field; while the next northerly field in the Raichoor Doab is still on its trial, explorations having only just been followed by regular mine openings.

The Kolar Field lies in the Mysore upland (the old Balaghat of South India, in contradistinction to the Payen Ghat or plains), at an elevation of about 2,000 feet above sea-level, about 150 miles due west of Madras, in a long synclinal fold of quartzites and schists with trap intrusions, among all of which run auriferous lodes of various width and value and extending to great depths. This belt averages about four miles in width, extending for a distance of fully forty miles north and south. There were several old mines of considerable extent, especially in the neighbourhood of Ooregaum, Kembli, and Saranpali, which had been excavated in what appeared to be true reef veins of quartz, though subsequent workings and petrological considerations show that some of the ore-bearing rock is not reef quartz, but highly-folded and interbedded quartz-rock, somewhat like that of the Transvaal ore beds. It was in some of these old excavations that Mr. Lavelle, practically the first pioneer for Mysore, carried on his perseveringly laborious explorations (however unfitted he may have been for such work either by education or training), the ultimate successful result of which he happily and contentedly lived to see realised.

Decidedly favourable shows of gold were obtained from his washings, and most encouraging specimens of more or less glassy dark-blueish quartz, with clearly visible pure gold, were easily obtained from the old pits and from thin two-foot lodes cropping out at the surface.

This was in the seventies; ere long, in conjunction with several influential men, sufficiently favourable results were obtained to justify the asking and obtaining of a mining grant from the government of Mysore, over some ten square miles of the Ooregaum part of the Kolar district. After this, the usual company construction, mining ventures, and explorations prevailed with varying success, which, however, kept slowly diminishing, on the whole, until but one of the original companies remained, and that one undecided whether to shut down or make one effort more. Such was the condition of affairs in 1879–80; and not only had the Kolar concession failed to all appearance, but this was the case also with Wainad, in the Malabar district, on the western side of the Madras presidency, where one of us had formed a very favourable opinion from the good show of true reefs and old workings. Thus the verdict seemed to be imminent that what had seemed to pay the old workers was not sufficiently remunerative for modern methods. Fortunately, courage and pluck did not fail, and the Mysore Gold Company held on until stone was encountered, assaying the average return anticipated and with a promising reef extension; and so, since 1886, there has been a steadily-increasing production.

THE MYSORE MINE.

Total returns from the commencement to date.

Date.	Tons of quartz crushed.	Tons of tailings treated.	Oz. bar gold from quartz and tailings.	Ounces Standard Gold.	Amount Realised.		
					£	s.	d.
Year ending—							
September, '84..	454	....	454	446.414	1,732	9	7
" '85..	1,616	....	3,754	3,776.335	14,675	4	5
" '86..	6,077	....	15,776	15,939.905	61,953	0	10
December, '87.. (15 months)	14,061	737	16,280	16,312.263	63,400	12	6
" '88..	20,191	4,319	19,090	18,868.859	73,349	13	1
" '89..	32,567	13,227	49,234	49,749.011	193,535	9	7
" '90..	38,812	18,535	58,181	59,082.313	229,966	16	4
" '91..	40,353	20,821	66,499	67,112.332	261,485	0	8
" '92..	44,548	38,727	64,391	64,004.279	249,331	15	1
" '93..	49,822	50,249	65,409	65,345.798	254.311	9	8
" '94..	60,957	54,511	52,273	52,249.578	203,087	6	2
" '95..	60,654	56,662	69,487	69,728.960	270,911	0	8
" '96..	64,297	71,642	108,781	109,330.781	425.586	1	4
	434,409	329,430	589,609	591,946.828	2,303,325	19	11

THE MYSORE MINE. RETURNS FOR 1896.—ORE STAMPED, TAILINGS TREATED, AND GOLD PRODUCED.

12 Months to 31st Dec, 1896.	Quartz treated and Gold extracted.					Tailings treated and Gold extracted.				Tailings treated by Cyanide process.				Total Bar Gold produced.	Standard Gold.	Net amount realised.		
	Quartz stamped.	Bar Gold extracted.	Produce per ton of Quartz.			Quantity of Tailings.	Bar Gold.	Produce per ton of Tailings.		Quantity of Tailings.	Bar Gold.	Produce per ton of Tailings.						
	Tons.	Ozs.	Ozs.	dwt.	gr.	Tons.	Ozs.	dwt.	gr.	Tons.	Ozs.	dwt.	gr.	Ozs.	Ozs.	£	s.	d.
January....	5351	8893	1	13	6	4570	999	4	9	1820	307	3	9	10199	10290.126	40,211	17	2
February...	5050	6186	1	4	12	3600	803	4	11	1750	306	3	12	7295	7303.594	28,379	17	0
March.....	5540	8042	1	9	1	3200	591	3	17	1820	301	3	7	8934	8995.843	34,972	19	11
April.....	5714	8088	1	8	8	3300	601	3	15	1705	260	3	7	8969	8974.084	34,881	13	0
May.....	5400	7162	1	6	13	4880	1350	5	13	1845	333	5	13	8845	8837.150	34,342	19	6
June.....	5328	7429	1	7	21	4380	1357	6	5	1610	169	2	2	8955	9005.828	35,024	10	8
July.....	5454	7621	1	7	23	4350	1167	5	9	1670	250	3	0	9038	9085.736	35,374	5	2
August.....	5300	7774	1	9	8	4460	1202	5	9	1760	157	1	19	9133	9181.025	35,766	13	3
September..	5060	7736	1	10	14	4300	1400	6	12	1677	192	2	7	9328	9365.517	36,478	6	7
October....	5290	7935	1	10	0	4405	1142	5	4	1820	254	2	19	9331	9397.259	36,590	15	11
November..	5300	8031	1	10	7	4440	1059	4	18	1890	251	2	16	9341	9405.564	36,622	5	5
December..	5510	8006	1	9	1	4640	1214	5	6	1750	193	2	5	9413	9489.055	36,939	17	9
	64297	92903	1	8	22	50525	12885	5	2	21117	2993	2	20	108781	109330.781	425,586	1	4

Selecting two of these operations, of which we have the returns from the commencement, the accompanying tables speak for the progress and production.

As regards the working and output of the Kolar Field generally, we append the interesting table on pages 784 and 785, extracted from an able article on "Gold Mining in the Colar Field of Mysore, India," in the *Mining World* of October 16, 1897.

In the above tables the amounts realised on the sale of the gold sold in London are given; but from these amounts the 5 per cent. royalty of the Mysore government must be deducted, and then the mining expenses, which are, of course, given in the annual reports of the mining companies. The mining expenses are, in all cases, much higher than was to have been expected, seeing that native labor is usually so cheap in India; but this is properly a question for the shareholders and the companies to settle among themselves. At any rate, the dividends of the paying concerns have been so satisfactory for several years that this question has not been of sufficient importance to call for serious consideration, while the reported reserves of stone available for treatment at the mills are sufficient to keep the question in abeyance for some time to come.

The next systematic exploration of the Dharwars has been carried on for some years in the Raichore Doab of the Nizam's dominions, about three hundred miles north-north-west of Hyderabad, at a place called Wondalli, which now gives its name to the company engaged

NUNDYDROOG MINE.

Total returns from the commencement to date.

Date.	Tons of quartz crushed.	Tons of tailings treated.	Oz. bar gold from quartz and tailings.	Ounces Standard Gold.	Amount realised.
					£ s. d.
Year ending—					
December, '82..	132	....	13	9.768	37 13 5
" '83..	335	....	35	24.828	95 19 6
" '86..	152	....	141	129.893	505 7 2
" '87..	890	....	1,546	1,474.859	5,737 18 10
" '88..	3,887	....	6,922	6,738.058	26,230 10 3
" '89..	3.781	....	6,127	5,840.155	22,773 7 1
" '90..	9,495	....	15,634	15,096.841	58,911 18 1
" '91..	11,750	1,508	23.592	22,809.745	89,084 3 5
" '92..	18,176	5,950	31,223	30,155.373	117,635 5 9
" '93..	25.760	6,989	27,734	26,458.405	103,107 13 2
" '94..	29,750	7,625	29,657	28,336.163	110,304 8 9
" '95..	32,975	7,775	38,923	36,966.126	144,079 14 10
" '96..	39,490	7,990	44,925	43,148.721	168,166 19 9
	127,975	30,379	141,239	134,909.415	525,658 16 6

NUNDYDROOG MINE. RETURNS FOR 1896.—ORE STAMPED, TAILINGS TREATED, AND GOLD PRODUCED.

12 Months to 31st Dec. 1896.	Quartz treated and Gold extracted.					Tailings treated and Gold extracted.					Total Bar Gold Produced.	Standard Gold.	Net amount realised.		
	Quartz stamped.	Bar Gold extracted.	Produce per ton of Quartz.			Quantity of Tailings.	Bar Gold extracted.	Produce per ton of Tailings.							
	Tons.	Ozs.	Ozs.	dwt.	gr.	Tons.	Ozs.	dwt	gr.		Ozs.	Ozs.	£	s.	d.
January	2800	3162	1	2	14	700	161	4	14		3323	3190.618	12,436	4	3
February	2700	3172	1	3	12	660	159	4	20		3331	3221.263	12,538	11	8
March	2800	3351	1	3	22	700	199	5	16		3550	3431.101	13,358	10	0
April.....	2740	3374	1	4	15	680	189	5	13		3563	3440.204	13,395	19	9
May	2750	3384	1	4	15	700	187	5	8		3571	3431.562	13,355	16	10
June.....	2410	3431	1	8	11	680	158	4	16		3589	3404.599	13,264	6	7
July	3550	3689	1	0	19	700	114	3	6		3803	3614.626	14,095	16	5
August.....	4000	3813	0	19	2	700	105	3	0		3918	3755.546	14,655	1	1
September ...	3900	3986	1	0	11	640	94	2	23		4080	3915.999	15,275	7	9
October	3950	3984	1	0	4	600	97	3	6		4081	3924.687	15,305	8	10
November ...	3950	4003	1	0	6	610	82	2	17		4085	3929.226	15,322	18	9
December ...	3940	3950	1	0	1	620	81	2	15		4031	3889.290	15,162	17	10
	39490	43299	1	1	22	7990	1626	4	2		44925	43148.721	168,166	19	9

TABLE SHOWING THE HEADS OF STAMPS ERECTED, TONS OF QUARTZ CRUSHED, OUNCES OF GOLD PRODUCED, AND VALUE, BY THE COMPANIES NOW AT WORK IN THE COLAR FIELD OF MYSORE, INDIA, FROM DEC. 31, 1896, TO SEPT. 30, 1897.

Month.	MYSORE.				NUNDYDROOG.				BALAGHAT-MYSORE.			
	Sts.	Tons.	†Ozs.	£	Sts.	Tons.	†Ozs.	£	Sts	Tons.	‡ Ozs.	£
Jan.	90	5,500	9,510	37,135	70	4,000	4,107	15,317	25	1,823	176	636
Feb.	...	5,100	9,523	37,159	...	3,700	4,242	15,944	..	.....	.....	.....
Mar.	...	5,530	9,631	37,909	...	4,000	4,284	15,964	..	.....	.....	.....
April	...	5,700	10,014	39,298	...	3,600	4,294	16,078	..	.....	.....	.....
May	...	5,400	10,242	39,884	...	3,620	4,639	17,443	..	.....	.....	.....
June	...	5,200	10,254	40,242	...	3,900	4,633	17,473	..	.....	.....	.....
July	120	5,312	10,309	40,286	...	4,125	4,772	17,962	..	.....	.....	.....
Aug.	...	7,550	11,008	42,830	...	4,155	4,784	17,780	..	.....	.....	.....
Sept.	...	7,267	11,037	*42,769	...	4,055	4,845	*18,775	..	.....	.....	.....
Total	120	52,559	91,528	357,512	70	35,155	40,600	152,736	25	1,823	176	636

Month.	OOREGUM.				CHAMPION REEFS.				MYSORE WEST & MYSORE-WYNAAD (TANK BLOCK).			
	Sts.	Tons.	Ozs	£	Sts	Tons.	†Ozs.	£	Sts	Tons.	Ozs.	£
Jan.	110	5,673	4,513	16,879	140	7,408	9,848	37,541	20	1,000	503	1,937
Feb.	...	5,409	4,671	17,316	...	7,113	9,971	37,843	..	1,100	594	2,291
Mar.	...	5,542	4,690	17,562	...	7,373	10,006	38,066	..	1,300	810	3,123
April	...	5,650	4,759	17,888	...	7,320	10,159	38,702	..	1,400	911	3.506
May	...	5,880	4,808	18,102	...	7,563	10,232	38,941	..	1,500	915	3,508
June	...	6,026	4,632	17,354	...	7,355	10,276	39,119	..	1,400	919	3.540
July	...	5,689	4,667	17,450	...	7,442	10,279	39,339	..	1,400	927	3,578
Aug.	...	5,708	4,617	17,350	...	7,428	10,435	39,792	..	1,400	934	* 3,620
Sept.	...	5,653	4,612	*17,872	...	7,270	10,570	*40,959	30	1,400	961	* 3.686
Total	110	51,230	41,969	157,773	140	66,272	91,794	350,302	30	11,900	7,464	28,789

Month.	MYSORE REEFS.				NINE REEFS.				COROMANDEL.			
	Sts.	Tons.	Ozs.	£	Sts.	Tons.	Ozs.	£	Sts	Tons.	† Ozs.	£
Jan.	26	727	237	895	40	153	56	*217	20	1,400	853	3,245
Feb.	...	412	182	683	...	253	105	*407	..	1,250	1,025	3,865
Mar.	...	233	123	466	...	237	63	*245	..	1,200	1,075	4,061
April	Not announced.			375	...	.....	.....	.....	..	1,300	1,105	4,122
May	...	.....	.....	.....	...	.....	.....	.....	..	1,100	1,142	4,287
June	...	.....	.....	.....	...	.....	.....	.....	..	1,100	1,158	4,361
July	...	.....	.....	.....	...	.....	.....	.....	..	1,250	1,170	4,397
Aug.	...	.....	.....	.....	...	... ..	.....	.....	..	1,300	1,178	4,455
Sept.	...	.....	.....	.....	...	.....	.....	.....	..	1,300	1,105	* 4,282
Total	26	1,372	542	2,419	40	643	224	869	20	11,200	9,811	37,075

† Returns from all sources.
* Estimated at £3⅞ per ounce.
The Mysore West Co. and Mysore Wynaad Co. own and work conjointly the Tank Block. The Goldfields of Mysore Co., in addition to the above returns, have yielded more than 1,000 ounces through the cyanide process and amalgamation.
‡ The return from the Balaghat-Mysore Mine was obtained, not from a fresh crushing, but by a treatment of tailings.

MONTH.	TOTAL FOR MONTH, 1897.	TOTAL FOR MONTH, 1896.
	£.	£.
January	113,082	88,144
February	115,508	103,163
March	117,396	100,273
April	119,969	102,550
May	122,165	102,413
June	122,089	118,341
July	123,012	99,955
August	125,827	102,278
September	128,343	105,055
Total	1,088,111	922,172

on the lately-started mine works. Mr. Foote wrote of the place in 1889:

"This Maski band is at the present time being energetically prospected by the prospecting staff of the Hyderabad (Deccan) Company. They have discovered very large numbers of old workings, many of them of considerable size and depth, proving beyond a doubt that a large and important gold-mining industry existed here a long time since, probably in the peaceful times before the Mussalman invasions. Many of the workings had evidently been deliberately filled up, probably to conceal them from the enemy. Dr. King and I paid a flying visit to this goldfield quite lately, and were shown several very important old workings near Wandalli and Topuldodi, to the north of Kavital (Kautala of the country people), besides numbers of lesser ones. The workings have in many cases been followed down to between forty and fifty feet, but then water comes in and prevents further exploration till pumps can be rigged up to drain them. This will be done very shortly, and the old workings will then be bottomed, when it will become possible to reach the undisturbed lodes and ascertain their real value. In the meantime encouraging shows of gold have been obtained from crushings of bits of the lodes left as props to the shaft walls. We saw two groups of 'mullockers,' or the small mortars in the rock in which the old miners pounded up the ore, or 'mullock.' One of these, close to the Topuldodi camp, showed the ordinary small mortars rather larger and deeper than half a cricket-ball, with several larger ones, like inverted dish-covers. The other group, about a mile north-west of the Wandalli camp, shows large, shallow, saucer-like hollows in the solid, tough trappoid. In these the ore was crushed, not by hand, but by working great rounded granite crushers, between half a ton and a ton in weight. The size of these crushers is so great that they must have been worked with some kind of framework by

which to get leverage to move them easily. A considerable number of these great crushers are to be seen, and several lie in their proper hollows. They must have been brought from several miles distance, and at no small expenditure of labour. It is abundantly evident that a great mining industry was once in progress in this Dharwar band; and there are at present good grounds for hoping that the reefs to be reached may, as in the case of several of the Kolar mines, turn out really rich enough to be profitably worked in European fashion."

Since this was written, we have watched a good deal of the further exploration with an interest begotten of early geological wanderings, and have had several opportunities of testing the excellent quality of the stone brought up,—a dark-grey, glassy quartz, with strong free gold, very like the stone first operated on at Kolar. A considerable advantage attaching to the enterprise is the comparative proximity to the Singareni coal field, from which much of the fuel used at the more distant Kolar field is supplied.

Looking next to the main display of the metalliferous series in this South Indian region, it must not be forgotten that these two gold tracts of Kolar and Wondalli are but the most eastern outlying belts. The much more extensive occurrence is in two great bands, or belts, further westward, the southern ends of which lie near Mysore city itself, whence they run north-north-westward for some three hundred and fifty miles, until they become hidden under the Deccan Trap flows of the Belgaum and Kaladgi districts of the Bombay presidency. Between these two big belts there are some fourteen or fifteen small outliers, all of which are enumerated as auriferous in the Mysore administration reports, one of them (Kempinkote) being now under a working mine company. In the greater band Mr. Foote refers to nine auriferous localities in the Mysore territory and one (the Dambul gold-field) in the Dharwar district, as marked by gold washings alone or situated close to old mine excavations.

The further direct continuity, or evident continuation, of the South-Indian transitions with those further to the north, or eastward in the peninsular region, is completely obscured by the great volcanic outburst now exhibited at the Deccan Trap area of more than 350,000 square miles, which spreads out over the Bombay presidency northwards into Rajputana, and eastwards by the central provinces to the edge of western Bengal. It is difficult, therefore, to correlate the rocks of central India, or those of western Bengal, and the central provinces, with the Madras Dharwars, although they are all submetamorphic and metalliferous. Still, the character of much of the eastern rocks is essentially Dharwar, while the Rajputana strata are not so clearly related.

In Rajputana the story of gold relates wholly to washings, except in one case, where specimens of gold in the matrix are reported, traditionally, to have been found in the old copper mines of Khetri. Very many gold-washing places are known in the central provinces, their sources being, no doubt, among the adjacent transition rocks, though some are supposed to be derived from quartz in gneissic areas; but there is no satisfactory record of any old mines other than those of lead and copper.

Western Bengal and Chota-Nagpore became famous some seven years ago, through many wild and speculative ventures in what were generally called the Bengal gold fields. At that time little more was known of this rather out-of-the-way and thinly-populated (mostly by aboriginal tribes) country of petty native States than that it consisted of a more or less schistose and trappoid area surrounded by the gneissic or crystalline series, in which gold was washed for; and that there were several old mine excavations, evidently for copper or lead, with perhaps one set of pits and drives having auriferous indications. Anyway, the gold fever was on to such an extent that geological survey warnings and deprecation were of no avail to allay it; and it practically burned itself out through preliminary trafficking in company formation and promotion, rash importation of machinery now lying idle and decaying in rushed-up mills, badly organised explorations, and false reports of discoveries and production. Only at the end, when a few men were driven to real efforts at exploration, with little money left, was any really valuable result obtained in the ascertainment of the fact that there were cases of ancient mining with filled-in shafts and adits, as well as old dump heaps; and that auriferous ore-stone having a bedded character is associated in some force with the hornblendic and chloritic schists. Confidence in this region of Indian gold-mining, however, had sustained too rude a shock, and funds for further work were not available; so the true condition of Chota-Nagpore remains a problem, even in the face of large and richly-auriferous samples of gold quartz from at least one mine.

The remaining tract of the peninsular area is that of Wainad, already incidentally referred to, but differing from those treated of, as in the Gneissic and granitoid rocks, which constitute the more prevalent and foundational series of the country. As with most of the precious ore tracts, the apparently richer part of Wainad is held under native tenure, with the mineral rights attaching thereto. The Nellumbur Rajah is the landholder of this particular part, his chief village being in the Malabar plains and situated close to some stream washings, whence, at regular seasons of the year, a fair amount of good yellow gold is washed by his people. The Wainad portion of

his estate is on what was once a fine coffee-bearing plateau, 3,000 feet above sea-level, which joins to the loftier (7,000 feet) British mountain land of the Nilgiri district. The lower upland is scored with the white outcrops of strong quartz reefs, auriferous in many places, particularly about Devallah; and there are several sites in this land of swampy flats, between wooded and cultivated undulations, for gold washing. The gold from the reefs is light-coloured, and so rather poor in quality,—a feature well known to the people, the choicer finds to them being, as they say, the "mud gold," which they can always get in small quantity from any spadeful of the surface-soil in some parts of Davallah. The country-rock of the upland is gneiss of various kinds, occasionally deeply weathered to a clayey rock, more or less gritty with the unaltered quartz foliæ, the foliation, and, indeed, the bedded arrangement of the series, having a W. S. W.–E. N. E. strike with a southerly dip. The reefs, sometimes fully twelve feet thick, and in one case about nine miles long, run generally N. N. W.-S. S. E., with an inclination to the eastward. Extensive working by the old miners is evident among the many reefs and their leaders around Devallah; but the gold extracted appears to have been gained mainly from the leaders, the more massive bodies of the reefs themselves having been neglected.

A preliminary geological survey report of this field was published in 1875, in response to a request from the Madras government, in the interests of a section of the coffee-planting community, which had been engaged for some years in desultory prospecting at the washings and reef outcrops. A brief *résumé* was given of all previous explorations and attempts to utilize the gold, and a favorable estimate was formed on the geological conditions and results of hand and improvised stamp treatment of the reef quartz.

Following this, the services of the late Mr. Brough Smyth, a specialist on gold mining in Australia and latterly minister of mines in the colony, were secured for a time by the government of India, when a further more elaborate and extended prospecting of the country was carried out with improved results, so that a successful development seemed assured. For, where the geological surveyor had run the average of his crushings to only about twelve pennyweights to the ton of quartz, Mr. Smyth's samplings occasionally amounted to more than an ounce to the ton, while, curiously enough, he, as well as the geologist in his day, happened to break up lumps of stone which quite blazed on the fractured surfaces with spangles of gold, which stone, of course, yielded remarkably rich samplings. Reports thus loaded were naturally seized on, and in one case there was a jumbling, in a telegraphic dispatch to London, of several ounces to the ton instead of an ounce

to several tons, which was sufficient to rouse the speculative market into violent operation. About this time the opening out of the country was, we feel sure, mismanaged in great part through the loss of a guiding hand by the death of Mr. Smyth. The largest operations were above ground and in the air, and it was only when work along this line ceased to be interesting that the reefs themselves were tackled. Several fresh explorations were organised on rearrangement of mining concessions and companies with further raising of capital, but the returns for any continued period of working always dropped to an average of three or four pennyweights in the ton,—certainly a sufficiently gloomy ending to all the ancient story of this being the Eldorado of biblical history, let alone the promise which public records and actual geological and mining survey foreshadowed. And yet there are those who still see a future of successful gold production when Wainad is more easily approachable by carriage or rail transport. This matter of transport was always a crushing item in expenditure, for there was either only the long route from the west coast ports over the forest-clad plains of Malabar, with weak bridges, and thence up the mountain road, or ghat, for 3,000 feet; or else there was the longer, though partially-railed, journey from the Madras side, with a final pull over the mountainous country of Mysore or the Nilgiris. Heavy machinery, imported for the great opening out, is still lying where it was abandoned on the bad parts of the western route, and a similar fate holds pieces of metal plant on the Nilgiri side.

The aspect of a profitable development of the gold-bearing rocks of peninsular India has changed, to all appearance for the worse; but it must not be forgotten that few, if any, of the tracts outside the Mysore area have had the continuously well-engineered and strong financial treatment that has been exercised within that region. When we ourselves knew Kolar in the early days,—that is, at the pegging-out of the first block in the ten-square-mile concession,—the venture was quite as problematical as any other talked of. Indeed, we can go so far as to say of Kolar itself that it might now be still the bare upland it was in 1875, instead of the present busy scene of flourishing mine and mill work, had it not been that the strong protest of the late most capable and worthy Captain Plummer, then of the Nundydroog mine, against shutting down, was fortunately acted on by the Mysore mine, when the disposal of their remaining capital was a matter of vital consideration.

As for Burma, most famed of all the eastern lands for gold and all the precious stones, even less can be said for it than for India proper as a gold locality, because the reported places have not as yet given any good results, nor are the geological conditions fully ascertained.

Upper Burma, towards the main confluence of the Irrawaddi, shows occasional reefs, or, perhaps, interbedded ore bodies, and some prospecting has been done; but few thoroughly reliable results can be expected until the country has been more opened out. Communication, transport, and labour are most serious difficulties, which will stand until there is an open railway route to Assam and Bengal. Other gold sources are reported along the eastern side of the Irrawaddi valley, below Mandalay, and thence southward through Tenassarim; but these also wait more careful and systematic prospecting than has been exercised on them hitherto, and, as in upper Burma, communication is difficult, and labour unobtainable except by importation from India. There is no doubt, however, that gold production existed in Burma before the British occupation, in sufficient quantity to excite the cupidity of its old native rulers, who exacted taxes, in certain parts of the country, which had to be paid in gold; and in upper Burma, particularly about Wuntho, gold can still be washed for. One of us visited this region, after a preliminary geological survey had been made, when it was evident that good yellow gold was obtainable in places from small leaders, and even from quartz ledges of definite extent; but these ledges were neither rich enough or of sufficient continuity to hold out any hope of profitable working. Of course, in a wild, jungle-clad country, like much of upper Burma, there may be larger reefs, but so far none have been met with. Travellers in the old days found it very hard to believe that the barbaric splendour of gilded pagodas and palaces, with the gem-like sparkle of their friezes, screens, and countless pinnacles, arise mainly from layers of gold leaf from China, with cunningly-arranged bits of looking-glass or glass castings from the Italian and English markets; but such is the fact. The king and his court kept the gold and precious stones to themselves, and these treasures were, after all, but the result of the hoarding up of dynasties.

It was, indeed, this long-continued treasuring of gold and jewels, not only in Burma, but at every old court and mansion of any state in India, which enabled the potentates and noblemen to display the stores that dazzled the eyes of their visitors and gave color to the belief that gold was actually obtainable in the country in correspondingly large quantity. Whatever the production, it was mainly gained from nature's own concentration processes of rock degradations and river siftings at a slow pace, and from distant sources, not only in peninsular India, but in the vast Himalayan region to the northwards,—altogether too slow a turn-out for these modern days of active British occupation and development, which demand a richly progressive opening-up like that of Mysore, or such as may confidently be expected from some of the many other tracts of auriferous occurrence indicated above.

THE APPLICATION OF ALTERNATING CURRENTS TO ELECTRIC TRACTION.

By Charles Henry Davis and Howard C. Forbes.

THE application of the alternating current for transmitting electrical energy to great distances has seemed to many the means of solving the problem of operating main lines of steam railroads by electric motors in place of steam locomotives. By means of the alternating current the energy from a water-power (or other source) can be carried a great distance to a railroad, which would thus obtain its motive power at an apparently trifling cost; hence in such cases it seems advisable, at first sight, to throw away the locomotives and operate the road by electricity. Much that is written on this subject leads to the conclusion that already sufficient development and perfection have been attained to make economical this substitution of electric traction on our present steam lines. A good deal has been said, however, by enthusiasts, that cannot be substantiated by critical analysis and comparison, although we have hope for future developments. The progress made during the past ten years is such that no one is justified in saying positively that "electricity will not be able to do it economically"; nevertheless the statements made in an article in THE ENGINEERING MAGAZINE for October, 1897, that (1) "where water-power is always available within a FEW hundred miles," (3) "for *desert* railways, where water cannot be obtained," etc., "electric traction is eminently suitable" may be dangerously misleading to the uninitiated, as we shall show in detail later. While many of those interested in the development and application of electricity have laid the greatest stress on its advantages as a means of utilizing "a cheap source of power," now it is understood that such a source of power may be the most expensive to develop, without any corresponding advantage in its use. The question of a "cheap source" of power is not the main issue. Assuming every other condition of maintenance and operation to be the same, and as economical in the one case as in the other, then that system which produces the cheapest power at the rim of the driving wheels, and not at its source, is the one to use. The problem is, therefore, not solely a question of the original cost of the power, although the advantage of cheap power is obvious, but rather the concentration of power and its long-distance transmission coupled with a cheap source, *versus* operation by small isolated units,—the steam locomotive.

In the May and June (1897) issues of THE ENGINEERING MAGAZINE, the article on "Electric Traction under Steam Railway Conditions" gave a detailed comparison of the advantages and disadvantages of these two systems as applied to our present steam roads; in brief, the conclusions were that electric traction can be profitably used:

(1) Where units are light, frequent, and run short distances.
(2) Where gross receipts will be increased more than gross expenses by the use of light and frequent units.
(3) Where competition of parallel roads using light and frequent units compels the change.
(4) Where higher speeds are required than can be attained by steam locomotives.

In these papers the use of direct currents transmitted over short distances was assumed, and the use of alternating current was not touched upon. The purpose of this article is to discuss the application of alternating-current motors and transmission lines to the various problems offered by our present steam-railway systems, and to bring out more particularly the apparent limitations of the possible developments of this application.

In discussing this question we shall first state the requirements of electric traction, and describe the application of alternating currents thereto. We shall then show that, although it may be possible to use the alternating current indirectly in operating railways, it does not follow that "where water-power is always available within a few hundred miles" it is advisable to use it, even for a new railroad. Finally, we shall take up specific cases illustrating the application of alternating current to railroads, and shall work out in detail a definite case, showing the relative economy in first cost and yearly expenses of operating a trunk line in two ways,—*viz.*,

(1) By long-distance electric transmission from a cheap source of power;

(2) By electric power station situated near the railway.

In the operation of railways, whether electric or steam lines, one requisite is that the speed of trains must be controlled by the operator; the variations of speed must be numerous, and the change from one to another must be sufficiently smooth to cause no discomfort to the passengers or excessive strain on any of the apparatus. The electric railway motor operating by direct current has long been used for this work with satisfactory results, and in its latest forms is sufficient and serviceable under the rough usage to which it must necessarily be subjected. The general appearance of one of the best forms of direct-current motor for railway service is shown in Fig. 1. The motor is

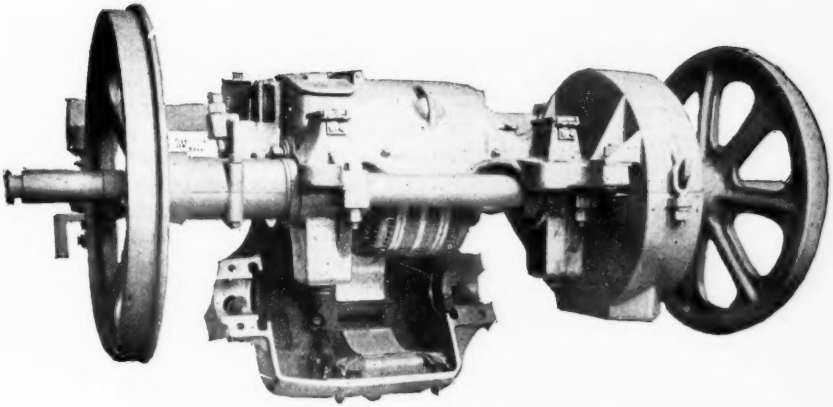


FIG. 1. DIRECT-CURRENT RAILWAY MOTOR.

protected by an iron waterproof case, and is geared directly to the axle of the car. In the direct-current motor the speed is varied by changing, by a controller, the amount of current supplied. A type of such controller is shown in Fig. 2.

With alternating-current motors the regulation of speed is more difficult. Until the recent development in "induction" motors the so-called "synchronous" motor was the only type worthy of practical consideration. This type derived its name from the fact that of necessity it ran at the same speed as the generator that supplied it with current. Obviously, therefore, the speed could not be varied. Besides, this, the "synchronous" motor would not start by itself under load. Hence it was unsuited for operating railway cars. The other form of alternating motor, the "induction" motor, is capable of speed-regulation to a limited extent, and is continually being improved, so that the future may see developments and improvements beyond our most sanguine expectations. A recent form of induction motor is shown in Fig. 3, while Fig. 4 shows a controlling device by which two variations in speed can be obtained. Alternating-current "induction" motors have certain characteristics which would be of great advantage in railway work. The most important of these is the absence of the commutator. Comparing Fig. 1 with Fig. 3, it will be noticed that the direct-current motor has at one end of the armature a cylinder larger than the shaft and several inches wide, upon which bear the brushes that carry the current. This is the commutator; it is made up of narrow copper strips carefully insulated. The commu-

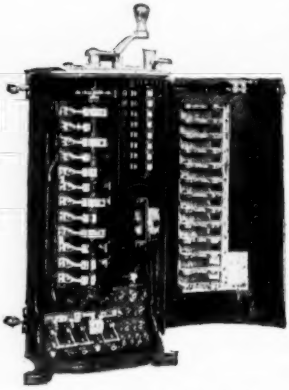


FIG. 2. SPEED CONTROLLER.

tator is the most vital part of the direct-current motor, requiring constant attention; if allowed to get out of order, it is liable to ruin the motor. On the induction motor, Fig. 3, there is no commutator. In other words, there is no electrical connection between the stationary parts of the "induction" motor and the armature or rotating part, and therefore there is no exposed metal carrying current, and no sparking due to the use of brushes. The "induction" motor is particularly adapted to run in dirty places with a slight amount of care, and will give far better service under such conditions than will direct-current motors, because of the absence of the commutator. On the other hand, the efficiency of the "induction" motor is not so high as that of the direct-current motor, and for railway purposes the means of controlling the speed is far inferior. The development in the use of alternating currents started with a single-phase generator, or, in other words, a machine delivering to the line a single pulsation which alternates in its direction. This current was satisfactory for lighting work, but unsuitable for power purposes, because, as explained before, the motors would not start under any considerable load, and their speeds could not be controlled. Our needs in the direction of power-utilization have led to the development of the multiphase generators, or, in other words, machines which deliver to the line two or more pulsations, each alternating in direction. The two-phase and the three-phase systems are the most usual to-day, although a greater number could be used.

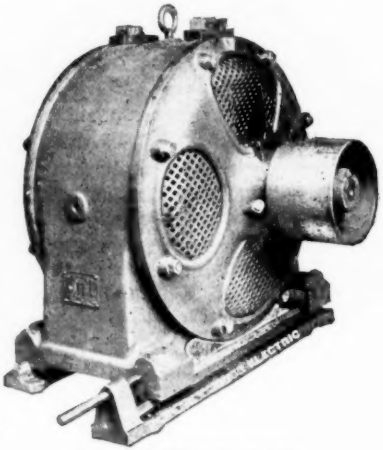


FIG. 3. INDUCTION MOTOR.

The use of multiphase currents has the following advantages:

(1) They allow some control of the speed of motors.

(2) They provide for starting motors when loaded, but not when over-loaded to the same extent as direct-current motors.

(3) They facilitate insulation.

(4) They overcome some of the effects of induction.

(5) They reduce the cost of conductors.

In short, then, the "induction" motor, like the "synchronous" motor, presents the difficulties of starting under loads as well as speed-control. The two-phase and three-phase "induction" motors have overcome these difficulties to a certain extent, and they offer improvements over direct-current motors.

(1) They require less attention.

(2) They give less trouble from dirt, dust, or water.

(3) They have no commutator.

(4) They have no moving electrical contacts, (except in special cases).

(5) There is less danger of burning out armatures.

(6) They require renewal of parts less frequently.

The disadvantages in their use can be summarized thus:

(1) They do not readily start with over-loads.

(2) Their speed cannot readily be controlled.

(3) Their efficiency is lower.

At present the disadvantages outweigh the advantages, in so far as the conditions of railway work are concerned.

Moreover, there are two other reasons against the present use of "induction" motors, which should have more or less weight, according to the conditions, but which cannot be charged against the motors themselves. We refer, first, to the effect on water pipes due to electrolytic action by currents returning in the ground from the rails to the power station. With the single-trolley alternating-current system the injury to the pipes spreads over the whole area surrounding the tracks, while with the direct current, by running the current from the generator into the trolley wire (trolley positive) and back through the track and ground returns, the deteriorating effect on the water pipes can be confined to a comparatively small area in the vicinity of the power station, where they can be easily watched and taken care of. Second, with the single-trolley system, the effect of induction is likely to cause considerable trouble on the telephone lines. The use of a double-trolley system to overcome these difficulties would lead to other and greater disadvantages in construction and insulation, which would to-day be insurmountable.

It seems, therefore, that the direct application of alternating-

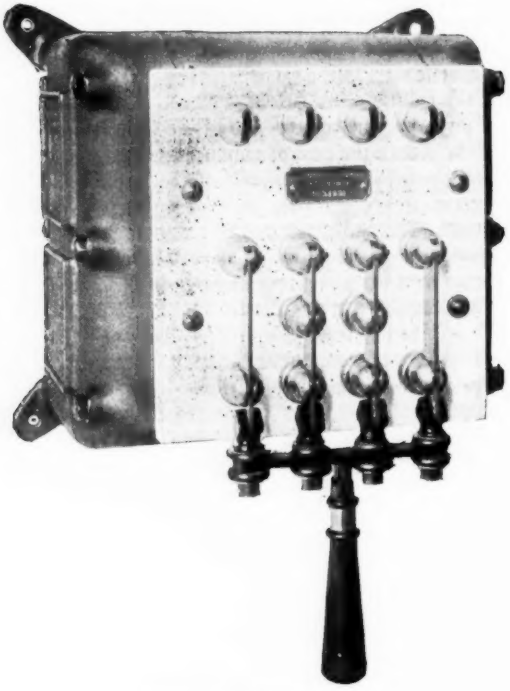


FIG. 4. SPEED CONTROLLER.

current motors to railway systems is not feasible to-day from a practicable standpoint, mainly for the reason that we cannot satisfactorily control variations in speed. Irrespective of the motors, however, the alternating current can be used indirectly in operating railway lines. The method, in brief, is to carry the alternating current from the power station to a point in close proximity to a section of the track. Here the current is changed from alternating to direct by means of the so-called rotary transformer, and then applied as direct current to the cars using direct-current motors, with the usual devices for controlling the speed. This method of using the alternating current introduces an extra transformation, with its concomitant loss, and its use is confined to cases where it is desired to transmit power from a distance. The fact that long-distance transmission can be accomplished more conveniently and economically by alternating

current than by direct is the reason why alternating current is used, and this advantage partly compensates for loss of power in the rotary converter. Alternating currents are better adapted than direct currents for transmitting power over long distances, because with the use of the latter we are now limited to comparatively low pressures, either in the generating plant (1,000-3,000 volts) or the motors (500-1,000 volts), while with the former we can "convert," and thus utilize between the generator and the motor, higher pressures than would be safe at either end. In transmitting currents of electricity over long or short distances there is a necessary loss in transmission, due to the power required to force the current through the wires. This loss is present in all circuits carrying a current of electricity in greater or less amount, depending upon the volume (amperes) of current (squared), and the quality, size, and length of the wire. In cases where large currents are to be carried long distances the loss is so increased that it requires special consideration. The principle involved in all long-distance transmission lines is to increase the pressure (voltage) to as high a point as practicable. This is done because the same amount of power can thereby be transmitted, at a correspondingly reduced current requiring a smaller wire, at the same or less loss, since the power is represented by the product of the current and the pressure. Hence, by reducing the current, the energy lost in the line is reduced in proportion to the square of the current. By thus increasing the pressure and reducing the current the original investment in the transmission line can be kept within reason, and the interest account reduced as well as the loss of energy in the line.

The limit to which this process of reducing the loss in transmission can be carried depends upon our ability to insulate wires carrying high pressures. There is no difficulty in using an alternating current running at a potential of 1,000 to 2,000 volts, for these pressures are common in the outside mains of lighting companies supplying alternating currrent for incandescent lighting in our cities and towns. For long-distance transmission, however, the pressure must be raised at least 10,000. This is now done successfully in a number of cases; the Niagara Falls transmission line is operated at 11,000 volts, and it is the intention to increase this to 22,000 volts. How soon higher pressures than this will become commercially practicable remains to be demonstrated by the development in the use of present electrical insulating materials or the discovery of new. In order to obtain high pressures, an intermediate step is required between the generator and the line, known as the "step-up" transformer, and another at the other end of the lines, known as the "step-down"

transformer. Generators are built at present to deliver not much more than 2,500 volts, and usually run from 1,000 to 2,000 volts. The "step-up" transformers take this voltage, and raise it, for transmission, to 10,000 or 20,000 volts. At the other end of the line the voltage is reduced to the desired amount, in a similar manner, by a "step-down" transformer, and then applied to the distributing lines, or to the rotary transformer, or to both, as the case may require. High insulation is therefore required from the "step-up" transformer along the transmission line to the "step-down" transformer. The required insulation is secured by special construction in the transformers, which are also filled with oil, and by insulators of special design attached to cross-arms and poles adapted for the purpose. A line insulator of high voltage is shown in Fig. 5.

The path of the current is as follows. A multiphase generator (Fig. 6) is operated by water or steam power, and run at 1,000 to 2,000 volts; the current is then raised to 10,000 volts or more by "step up" transformers (Fig. 7); from here the current is transmitted at this voltage to a so-called sub-station at the other end of the line; here are located the "step-down" transformers (Fig. 7), which take the voltage at 10,000 from the line, and convert it to the proper voltage for street-railway service; the current then goes to the rotary transformer (Fig. 8). This machine may be best described as a motor and generator combined. The alternating current is here applied at one end, and the direct current, suitable for use on the railway lines, is taken off at the other; from here the current goes to the trolley line, to the motor on the car, to the ground, and returns to the rotary transformer at its direct-current end. Where the power is used for other purposes as well as operating railways, many variations of this method are employed.

We have shown so far that the alternating-current motor cannot to-day be used under the cars in place of direct-current motors, or at the head of the train in the form of an electric locomotive; but the usefulness of the alternating current in railway work is confined to the facilities with which it can be transmitted over long distances. On account of the high voltage that can be used in alternating-current transmission, and the saving in the cost of transmission lines resulting therefrom, it is possible to utilize water powers situated at a distance from the railway lines. We now come to the question whether, having a source "where water power is always available within a few hundred miles," it is advisable to utilize it.

Search for a "cheap source" of power must be careful, as its use often results in increased cost of operation and maintenance.

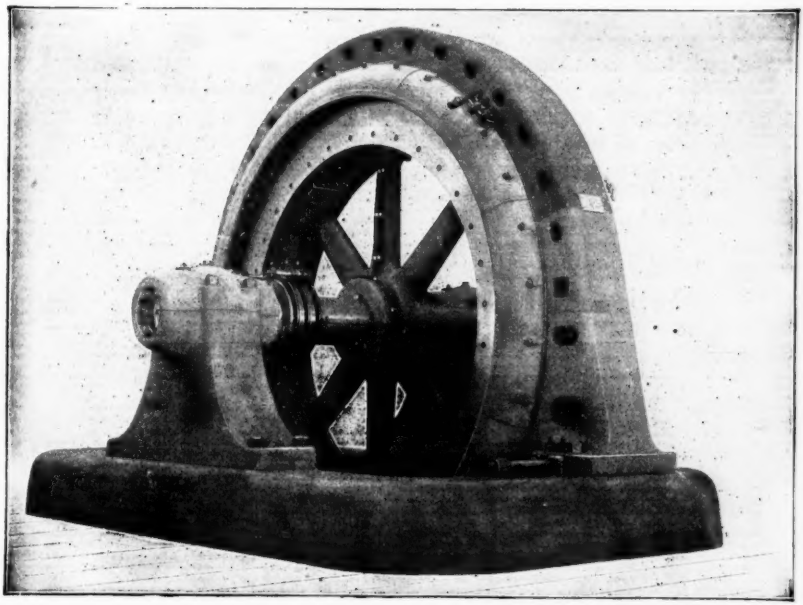


FIG. 6. A MULTIPHASE GENERATOR.

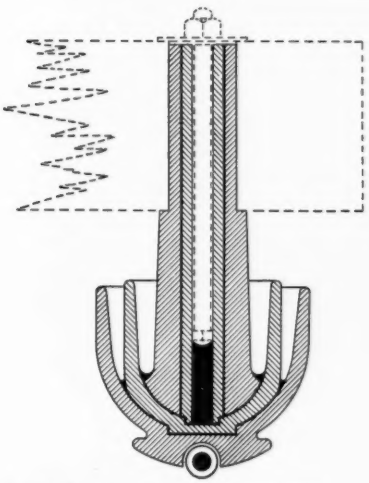


FIG. 5. A HIGH-VOLTAGE INSULATOR.

FIG. 7. A TRANSFORMER.

This more clearly appears when one remembers that "power" on an electric road represents only 11.5 per cent. (fair average) of the total cost per car-mile, while cars represent 19 per cent., track and line 27 per cent., and car labor 42.5 per cent. This power is produced by steam, and the coal item equals about 50 per cent. of the power cost, or 5.75 per cent. of the total cost per car-mile,—a very small percentage upon which to save by the use of a water power situated "several hundred miles" from the railway line and requiring a large outlay to develop it, to say nothing of the cost of the transmission line and its maintenance. Could 46 per cent. of 5.75 per cent. be saved, it would be equivalent to a saving of only 10 per cent. on cars, 7.4 per cent. on track and line, or 4.7 per cent. on car-help, any of which savings probably could be accomplished, in a given case, with a much smaller expenditure of capital. (For further details see "Comparative Economy in Electric Railway Operation," March, 1897, issue of THE ENGINEERING MAGAZINE.) Furthermore, the cost of fuel for locomotives on trunk railways is approximately 8 per cent. (fair average) of the total cost per train-mile, which, with present compound engines, would be materially reduced (see "The Enormous Possibilities of Rapid Electric Travel," ENGINEERING MAGAZINE, 1897), so that but a very small percentage of the total cost per train-mile can be saved.

We feel that, while continual progress is being made in the direction of applying a combination of alternating and direct electric currents to railways, and while at present, in specific cases, it can be shown to be economical on paper, mainly from theoretical consideration of the physical characteristics, yet at the same time, from a business standpoint, so large a factor of safety must be inserted into such calculations in order to warrant the experiment that the actual transition from steam to electricity on the trunk-line railroads does not seem to be near at hand. At present such a change is hardly warranted, and it is unlikely that it would be accompanied by a saving sufficient to cover the interest and depreciation on the investment necessitated, even considering only that portion of a line running wholly within one hundred miles of a water-power. The deciding factor is the cost of developing and transmitting the power rather than the fact that cheap power can be obtained. The majority of water powers, especially in the eastern part of the United States, have not sufficient head to render the transmission of their power a commercial success to-day over long distances; what future development may bring we cannot say.

While, in general, present trunk lines cannot now be profitably converted to electric traction, even by the use of alternating cur-

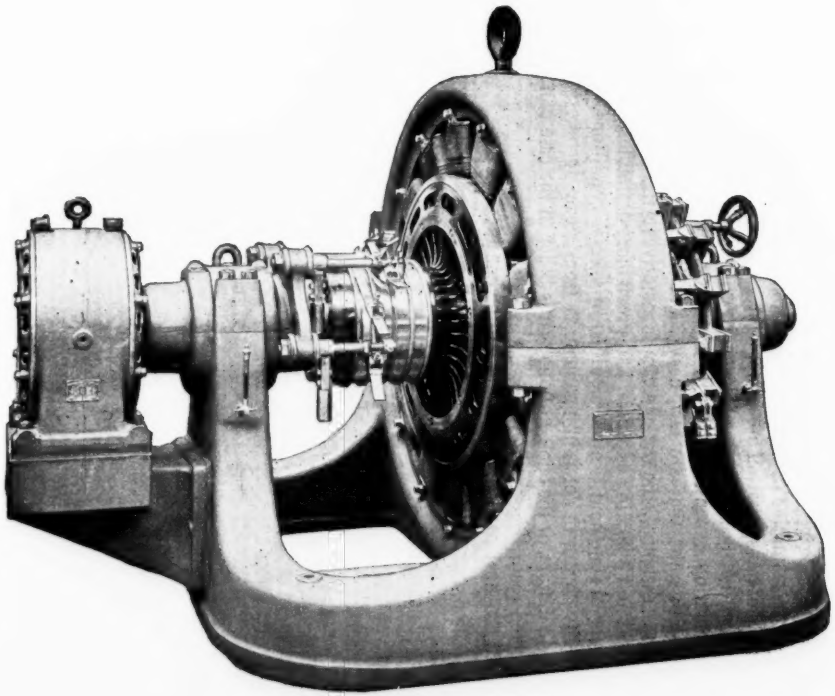


FIG. 8. A ROTARY TRANSFORMER.

rents, parts of such systems may be, and where a new line is to be built, or where very high speeds and short headways are required, it will be advisable to consider electric traction.

To quote from the writer's paper on "Electric Traction under Steam Railway Conditions," in THE ENGINEERING MAGAZINE, May, 1897:

"In making a comparison of the use of steam locomotives and electric motors as motive powers, it will be found, in general, that, where the units of transportation are many, light, and frequent, and operated over short distances, the use of electricity will result in lower first cost and operating expenses, and will be more desirable in many ways; while with units that are few, heavy, and infrequent, and operated over long distances, the use of steam locomotives will result in lower first cost and operating expenses, and prove more desirable. Though this general statement is often modified by special conditions, it will generally govern in determining changes from steam locomotives to electric motors, or the choice of one or the other in the case of newly-projected roads."

In the next paper specific cases will be considered.

REVIEW OF THE ENGINEERING PRESS

Progress in Timber Physics.

THE division of forestry of the United States department of agriculture, in its circular No. 18, recently issued, gives some valuable information concerning the subject of timber physics, especially with relation to the influence of size of test pieces upon the results, and to the range of variation in strength which may reasonably be expected.

The tests made at Washington, though unfortunately interrupted by fire, were carried far enough to enable a number of valuable points to be determined, the most important conclusions being:

"1. A difference in strength values derived from a few specimens of the same kind of wood, up to 10 per cent. for coniferous wood and to 15 per cent. for hard woods, can not be considered a difference of practical importance; such differences cannot be relied upon as furnishing a criterion of the value of the material.

"2. The size of the test piece does not in itself influence strength values, except in compression endwise when the size is less than a cube.

"3. Small test pieces judiciously selected furnish a better statement of average values of a species than tests on large beams and columns in small numbers.

"4. A large series of tests on small pieces will give practically the same result as such a series on large beams and columns; hence, there is no need of finding a coefficient, with which to relate the results of the former to construction members.

"5. The influence of moisture on strength appears even greater than the former tests and statements from this division have indicated."

These statements are of the utmost importance in connection with the use of timber in construction, for, if tests on small pieces are sufficient to give knowledge of the strength of a wood within the limits of variation of commercial pieces, there is no need of expensive and inconvenient tests of full-size pieces, and testing may be undertaken much more frequently than formerly.

"Wood, as is well known, is a non-homogeneous material, and hence is extremely variable in its strength and other properties; so much so that it has often been doubted whether any test series could produce reliable standard values."

When, however, the limits of such variability are fairly well understood, as indicated above, there is no reason why tests should not be of much value. It is in the judicious use of test results that their true value lies.

"Discussions, needless controversies, and false conclusions on the relative value of various wood materials or processes of treatment, have been frequent, having been based on differences of test data, which might have been within the range of variability of each material by itself, the difference being too small to predicate quality of the material in general. Small differences, such as a few hundred pounds in values of 10,000 pounds or more, have been regarded as deciding for or against a whole series of material or a species, or have been utilized to establish a superiority of various processes of treatment or methods of testing or computation."

When it is found, therefore, that the range of variation between the results of tests on full size pieces and on small specimens lies well within the variability of the material itself, the supposed advantage of using large test pieces disappears, while in its place comes the gain due to the greater number of small pieces which can be tested.

An important discovery, in connection with the work of the laboratory has been worked out by Mr. S. T. Neely, and is stated as follows:

"The strength of beams at elastic limit is equal to the strength of the material in compression, and the strength of beams at rupture can, it appears, be directly calcu-

lated from the compression strength; the relation of compression strength to the breaking load of a beam is capable of mathematical expression."

Assuming this statement to be correct,—and it appears to be sustained by the many tests made by the department,—the strength of beams of any desired wood may readily be determined by very simple tests; and there appears to be no good reason why any timber structure should be constructed without a full knowledge of its strength, within the limits of the variation in the strength of the material.

There has been some criticism of the manner in which the materials were selected for these tests, the point having been made that the pieces used represented a much higher grade of timber than is ordinarily used in actual construction. This point perhaps would be well taken, if the results made any claim to a very high degree of precision; but, it having been clearly stated that the variation between the strength of various specimens may reach 15 per cent. of the total strength, it is evident that this point has been fairly considered. Altogether the tests represent good work done in the important line of timber physics, and it is to be hoped that the cessation may be only temporary.

The New Croton Dam.

IN the course of the development of the plans for the collection, storage, and delivery of the water of the Croton valley to New York city the original scheme has undergone a number of modifications. The new aqueduct has been completed, but the idea of constructing the projected Quaker Bridge dam, to impound the entire drainage of the whole water-shed, has been practically abandoned, and, instead, several smaller dams are to be constructed. Of these dams that at the Cornell site, across the Croton river, is the most important, and from an excellent account in the *Engineering Record* some description of the plan, and of the present condition of the work upon it, is abstracted.

"The main structure is a masonry wall, founded on solid rock far below the natural surface, with a core wall continued into the hillside at the south end, where the bulk of the structure is mostly earth embankment. The north end is curved up-stream, nearly at right angles, parallel to the hillside, to make a long overfall."

This masonry dam will certainly be the largest in the United States, and probably in the world, as its extreme height from bed-rock will be 290 feet, and the length of the masonry portion will be 700 feet. The thickness at the bottom will be 200 feet, diminishing to an 18-foot roadway at the top. The overflow, which extends at right angles with the masonry dam, forms a channel by the side of the dam, providing a spillway of nearly 1,000 feet in length, thus furnishing ample relief for the greatest discharge to be expected.

The cost of the work is estimated at nearly $5,000,000, and since 1892, when the first contracts were let, nearly half this amount has been expended.

"The diversion and protecting works were costly, and required considerable time to construct, while the excavation of a pit about 1,300 × 500 feet on top, and of a maximum depth of about 300 feet from the highest point of the original surface to the lowest part of the pit, involved the removal of about 900,000 cubic yards of earth, and 100,000 yards of rock, some of it from a depth of 130 feet below the original bed of the river, and the hoisting and conveying of the spoil to considerable distances. The last of this work was completed in September, 1897, and, on October 1, 144,000 of the 650,000 cubic yards of masonry had been laid."

In so important a work as this, where the consequences of failure would be so serious, the greatest care must be taken to insure perfection of workmanship; so especial precautions were observed in preparing the foundation of the masonry upon the bed rock.

The accepted surface of the rock was scraped clean, swept, and washed with a jet of water under heavy pressure. After painting with a wash of pure Portland cement, the bed for each stone was covered with thick cement mortar; then the stone was lowered upon it, raised again,

to observe the impression, and again lowered and thoroughly bedded. Constant and vigilant inspection has been maintained over all portions of the masonry construction.

The handling of the materials involves the use of wire-rope cableways, besides many derricks, trackways, locomotives, and cars; and a force of 750 men find employment upon the masonry construction work.

The progress already made promises successful completion by 1901, all elements of uncertainty being now removed. The dam has been designed by Mr. Alphonse Fteley, the chief engineer of the Croton aqueduct, and president of the American Society of Civil Engineers, who, with an efficient corps of assistants, is in full charge of the execution of the work.

The account in the *Engineering Record* is accompanied by reproductions of a number of photographs showing the progress of the work, at various stages, together with topographical plans and sections, giving a far better idea of the nature and magnitude of the undertaking than can possibly be conveyed by any description.

Hinged Masonry Arches.

THE revival of the past few years in favor of masonry arches has in great part developed from increased study, and the assurance that increased knowledge has given as to the real stability and strength of structures built in accordance with the modern theory.

The old statical theory, which has come down to us from the time of Coulomb and his followers, depended for its demonstration upon certain assumptions which, while convenient, were by no means in accordance with the facts; and the result was the development of empirical rules, which carried with them the usual amount of uncertainty.

Among these uncertain elements the most important was the exact location of the position of the line of pressure at the abutment; and, when, in the case of moving loads, there was a certainty that the position of the centre of pressure at the crown and at the abutments varied according to the elasticity of the material, the unreliability of the statical theory became apparent.

The results of the important tests made by the Austrian Society of Engineers upon full-sized arches demonstrated so fully the correctness of the elastic theory that it is now no longer open to question, and the present problem is rather as to the best method of so controlling the direction of the forces as to maintain them within the desired constructive limits.

A valuable paper upon the subject of three-hinged masonry arches, with especial reference to long spans, by Mr. David A. Molitor, appears in the *Proceedings of the American Society of Civil Engineers*, and in it are contained some important points concerning the construction of masonry arches.

"Essentially all the harassing features of fixed masonry arches are overcome by the introduction of hinges at the crown and abutments, thus permitting a rigid analytical treatment, and affording almost absolute safety against cracks, even though small settlements may take place in the abutments." The idea was introduced by Köpcke, of Dresden, in 1880, by providing open joints at crown and haunches. Karl v. Leibbrand, at Stuttgart, in 1885, substituted sheet lead for the open joints, and applied cast iron hinged bearings in 1893; these having already been advocated by the author in 1888.

Hinged joints in masonry arches have already been applied successfully in arches of considerable span, and Mr. Molitor gives a list which in itself should be enough to convince the most sceptical that there is no constructive objection or difficulty worthy of consideration.

Among these especially may be noted the Munderkingen Arch, of 50 metres' span, across the Danube, constructed of concrete with a rise of only $\frac{1}{10}$ the span. This was designed by Leibbrand, and its success undoubtedly settled the correctness of the method.

Mr. Molitor presented his paper in the hope that it might be the means of introducing this form of arch construction into

the United States and gives at some length the computations and equations for the three-hinged arch. The graphical method for determining the deformation under unsymmetrical loading or displacement of abutment is developed, and the most reliable values for the moduli of elasticity and coefficients of shrinkage of cement are given, although it is suggested that these should be checked by actual determinations in the case of any given structure.

The paper closes with a complete detailed solution of a problem whose object is the design of an arch to meet certain given conditions. The entire design is worked out in a satisfactory manner. If for no other reason, this portion of the paper should be welcomed, showing, as it does, that the shape of the arch curve should not be arbitrarily selected at first, but should be permitted to develop from the conditions of the problem.

It is, indeed, to be hoped that Mr. Molitor's paper may lead to a more scientific and rational development of arch design and construction in America, and that this most effective, beautiful, and scientific method of spanning openings may be used wherever practicable, to the exclusion of the hideous metallic truss.

The New American Battle-ships.

REFERRING to the decision of the Board of Construction of the United States Navy Department that the three new battleships provided for by congress shall have a speed of only 15 to 16 knots, *Engineering News* makes a strong and timely protest against so mistaken a policy, in which protest we cheerfully join. If the recent events of the war between Spain and the United States have demonstrated anything, it has been the supreme value of speed in naval warfare. Under such circumstances, and against the direct opinion of the able Chief of the Bureau of Steam Engineering, Commodore Melville, it appears little short of criminal for the Board of Construction to advise the construction of battle-ships which will be surpassed in speed by at least fifty similar vessels in the possession of other nations.

It is not because fast vessels cannot be built that the sluggish Board of Naval Construction does not recommend them. The Bureau of Steam Engineering offered plans for 18-knot vessels, involving the latest types of water-tube boilers and quadruple-expansion engines, and promising a saving in weight of 350 tons, but this offer, made by engineers who are well known to be entirely capable of fulfilling any requirements which they may accept, has apparently been passed over, in order that existing plans, already more or less antiquated, may be used.

It may not be too late to urge upon congress the magnitude of the blunder which has thus been made. In the light of recent experience, and with the advice of such men as Mahan, in America, and Clowes, in England, the importance of speed in naval warefare is certainly well worth considering; and it is to be hoped that, before it is too late, the wise plans of the Engineer-in-Chief will be adopted, and that the minimum speed-capacity of the new battle-ships may be placed at 18 knots, with liberal premiums for any excess.

Testing Cast Iron.

AMONG a number of valuable papers presented at the Cincinnati convention of the American Foundrymen's Association was one upon the adoption of a standard system of test bars for cast iron, by Dr. Moldenke.

The paper first called attention to the fact that, while in the United States much success has been attained in the production of large and intricate castings, there is need for a closer study of the properties of the material of which they are made. There is practically no attempt at uniformity in methods of testing, and the whole matter is in a chaotic state.

The standard forms and methods of preparing test bars, as used in Germany, were described and illustrated, and a number of practical objections raised.

"We all recognize the fact that, after all, the judging of quality in a material by means of test bars can only be a relative one. Steel, after casting, is subjected to

a variety of heat and working processes, leaving the structure of the finished product in a very different form from that of the original. Cast iron, on the other hand, remains just as cast. As there is no possibility of wiping out the chilling effect of the mould, the variation in structure due to casting temperatures, rate of cooling, etc., the test bars by which a casting is to be judged should approach as nearly as possible the peculiar conditions obtaining at the time."

It is owing to the difficulty of accomplishing this that there is so much diversity of opinion among practical foundrymen. The practice of many foundries—of breaking the first castings made in filling a regular contract, in order to detect any defects in methods of moulding, pouring, etc.—is commended as the most practical plan for articles of moderate size made in large quantity. The next best method is to cut out test pieces from finished castings rejected for some surface blemish not due to extremes of temperature while being poured. This at least will enable a general opinion to be formed as to the quality of the material and its adaptability for the purpose intended.

Dr. Moldenke urged that steps be taken to make the Foundrymen's Association a member of the International Society for the Unification of Methods of Testing Materials of Construction, in order that it might join the work of the other large socities interested in industrial progress, and he expressed his belief that the discussion of the special subject of testing cast iron would lead to the adoption of a satisfactory international code, in which American practice would find recognition.

In a general way he expressed his own views as to the character of standard test pieces, as follows:

"For the tensile test, a bar should be round and of large diameter. The peculiar requirements of the transverse test seem to demand a square and thick bar. Test bars should all be cast vertically, to avoid the variation in strength in the upper and lower sides when cast flat. The effect of a dry sand mould should be obtained, to remove all disturbing influences due to the varying dampness of green sand moulds. These are a few of the points to be considered in the making of the test bar, its preparation for the machine requiring further study."

In connection with Dr. Moldenke's paper it is interesting to note that the American section of the International Association for Testing Materials has been formally organized with the following officers: chairman, Prof. Mansfield Merriman; vice-chairman, Prof. Henry M. Howe; treasurer, Paul Kreuzpointner; secretary, R. L. Humphrey. These officers, together with Mr. Gus C. Henning, the American member of the council, constitute the executive committee.

Undoubtedly this organization will advance the interest in the work of the International Association, so far as America is concerned and at the next general meeting of the association, in Paris, in 1900, substantial results may be expected.

Compensating Reservoirs.

ONE of the greatest difficulties with which the hydraulic engineer has had to contend in connection with the establishment of gravity water-supply schemes has been the old common-law right of every riparian owner or dweller along a stream to have all of a stream flow past his premises forever. Many a promising gravity water-works scheme has been blocked by the obstruction thus created.

In a valuable paper presented before the recent convention of the American Water Works Association at Buffalo Mr. Stephen E. Babcock discusses this difficulty, and suggests a possible remedy.

By reference to various judicial decisions Mr. Babcock fairly establishes the proposition that the riparian owner has no property interest in the water itself, but a right only to its use as it flows along; indeed, all the American decisions are apparently based on the opinion of Lord Ellenborough that "every man is entitled to a stream of water flowing through his land without diminution or alteration."

The principal difficulty to be met here lies in the question as to the right to the excess flow over and above the normal

flow of the stream, and attempts have been made to show that storm waters, or the waste product of water passing along in times of freshet, also constitute a property value to the riparian owner, and must be accounted for to the owner of the land, as well as the ordinary flow which the machinery may be adapted to use during the greater part of the year.

It is this question of the ownership of the excess flow of water which forms the theme of Mr. Babcock's paper, and the matter is evidently one of much importance, since, by the construction of compensating reservoirs, the excess water may be retained and used for purposes of water-supply without infringing on the rights of the owner of the land so far as the average flow is concerned.

The older decisions take no account of the relative amount of water passing at different times of the year. We have in hydraulic engineering a condition of streams known as the average flow, storm flow, ordinary (or normal) flow, and minimum flow. The average flow may be considered as based upon the entire flow for the year, and is the entire flow of the year divided by the number of minutes or seconds in the year. The ordinary (or normal) flow, is the flow which can be depended upon for eight or nine months of the year, and it is for this flow that a riparian owner adapts his machinery.

Under these conditions Mr. Babcock contends that the storage of excess water works no hardship to the riparian owner, and that so long as the party storing or conserving this water product allows the ordinary and minimum flow to pass down the stream, the riparian owner can have no claim for damages, and the party who conserves the waste water may do what he pleases with it. A number of English authorities are quoted in support of this proposition.

Mr. Babcock then proceeds to show how, by careful gaugings, an equitable division of flood waters from ordinary discharge may be made, and then cites the case of the city of Little Falls, N. Y., in which an additional supply of water was secured by this method.

Testing Bicycles.

ALTHOUGH the bicycle is one of the highest developments of modern machine-design, and represents a remarkable example of evolution in mechanical construction, it is but recently that its mechanical efficiency and strength have been scientifically investigated. Some of the manufacturers have, of late, introduced testing laboratories in connection with their productive work, but for general and public research facilities have only recently been offered.

A very complete testing equipment is now installed in the laboratories of Sibley College, Cornell University, and from a paper by Messrs. A. H. Eldredge and G. B. Preston, published in *Machinery*, we are able to give some account of the apparatus and the results deduced from its use.

Bicycle tests are sometimes made on the road, using dynamometers attached to the machine, and measuring the speed and grade, and some useful information has been obtained in this manner; but, as the local conditions of the road, the actual atmospheric resistance, and the individual characteristics of the rider are all indeterminate qualities, such tests do not give comparable results.

Laboratory tests also have their objectionable features, but, as the conditions are all under control, it is possible by such tests to investigate the action of the various parts, and also to compare wheels of different styles in a scientific manner.

In the laboratory test the rear wheel of the bicycle is supported upon the rim of another wheel directly under the bicycle wheel and in the same plane. This supporting wheel, called the track wheel, takes the place of the road-bed, and by means of it the rear wheel of the bicycle can be driven from the crank shaft through the bicycle gearing at a speed of rotation corresponding to any speed of translation desired. An absorption dynamometer is attached to the axis of the track wheel, and a transmission dynamometer to the bicycle crank shaft.

This apparatus enables any desired conditions as to saddle-load, tire-pressure,

speed, and equivalent grade to be introduced, and the corresponding efficiency to be determined in a comparable manner for any number of wheels, while investigations as to the effect of varying the conditions for a single wheel give valuable information concerning constructive features.

The tests described in the article referred to were conducted for the purpose of comparing the resistance of different types of wheels, made by the same establishment, but differing in weight, shape, and style of gear, the wheels including standard, racer, and drop-frame chain wheels, and also a standard chainless machine.

Tests were also made to determine the following points:

Effect of tire-pressure and saddle-load upon the efficiency of propulsion, both with single and double tube tires of various weights;

The change of resistance due to change of speed;

The effect of the alternate thrust upon the two opposite crank shaft bearings, due to the action of pedaling;

Whether or no a bicycle deteriorates by use;

The relative efficiency of the solid rubber tire, the cushion tire, and the pneumatic tire.

Before making the actual tests, the various parts of the apparatus were run without other load than that due to the resistance of the testing mechanism, so that the necessary calibrations could be made, and the influences due to the apparatus itself could be clearly distinguished from the action of the bicycle undergoing test. The crank shaft of the wheel was driven by an electric motor, with universal-joint connection, thus eliminating any imperfections in alignment, while the speeds were indicated by a tachymeter, and recorded by an electric speed register.

The results of the tests were too voluminous to be recorded here, and in the original paper they are shown in the form of curves, which enable the relative efficiencies to be seen very clearly. Some of the conclusions, however, are of much interest, and may be given.

In the first place, as has already been discovered, the point of greatest influence upon the efficiency of a bicycle is the tire. Different tires, even when of the same make and supposed to be of the same grade, when attached to the same wheel, pumped to the same pressure, and carrying the same load, vary several per cent. in efficiency. In order to determine the efficiency of the other parts of a bicycle, therefore, it became necessary to test it with the tire removed, and a number of such tests are given.

In regard to the influence of the style of frame, it was found that the drop frame and the standard pattern did not vary more than two per cent. in the riding limit, while the chainless machine lay several per cent. below, and the racer an equal amount above; but the entire difference was no more than is found to exist between tires of the same make and grade; so that, for all practical purposes, the various styles may be considered equal.

The influence of the pedaling action, which was imitated by attaching weights to the cranks in such a manner as to give the alternating up-and-down thrust, was greatest on the light racing frame, as might have been expected. It was also greater, within the riding limits, for the drop frame than for the standard, but very small in all three cases.

The difference between old and new wheels was found to be little, if any, more than between two new wheels of the same make.

The pneumatic tire, while shown to be an inefficient transmitting device, is, when compared with the solid and cushion tire, the greatest advance yet made in bicycle construction.

A very interesting feature of the tests was the actual determination of the power exerted by an expert rider. This was done by placing the rider in the saddle and causing him to drive the cranks at a speed corresponding to ten miles an hour. The brake was then adjusted to the greatest resistance that the rider was capable of overcoming, and, from the brake-reading thus obtained, and the known efficiency of the bicycle, the number of foot-pounds per

mile put into the bicycle by the rider was found. This was done with two different riders, both stronger than the average, and the maximum was found to be 40,000 foot-pounds per mile. This corresponds to a continuous pedal pressure of 42 pounds, or, at the speed of ten miles per hour, to one-fifth of a horse power.

Loss of Water from Reservoirs.

IN determining the condition of a reservoir as to tightness or security against leakage, it is necessary to make allowance for such losses as occur from causes other than direct leaks. One of these causes of diminution in the contents is that of evaporation, and in sections where the relative humidity of the atmosphere is low this is amply sufficient to need investigation. In most cases the measurement of evaporation-losses from reservoirs has to be made for each case, as very little recorded information is available, and the conditions vary for different localities.

A valuable paper upon this subject has been prepared by Mr. L. G. Carpenter, of the State agricultural experiment station at Fort Collins, Colorado, and published as a station bulletin. The tests were intended to cover the losses by seepage as well as by evaporation, but it was found that the loss by seepage was less than was expected, and that the loss by evaporation was correspondingly more important.

It is well known from meteorological investigations of humidity that the capacity of the air for moisture depends upon its temperature, upon its dryness, and upon the freedom with which it circulates, and the same conditions appear in connection with lake and reservoir evaporation. As Mr. Carpenter says, "The amount of evaporation depends upon the the temperature of the water, upon the dryness of the air, and upon the wind. The wind brings fresh, unsaturated air in contact with the water surface, and gives opportunity for more vapor to be absorbed. Unless the temperature of the water surface is warmer than the dew-point of the air, evaporation cannot proceed; if lower, condensation may take place."

The tests were made by observing the difference in level in a standard tank 3 feet square and 3 feet deep, the depth being measured to the nearest thousandth of a foot, twice daily. Corrections for rainfall were taken from the readings of a rain-gauge, and, as tabulated, the monthly averages are given for each month in the year from 1887 to 1897. The maximum evaporation (average) in one month was for July, being 5.44 inches, and the minimum for December, being 1.22 inches, the average yearly evaporation for eleven years being 41 inches.

It might at first be supposed that the elevation of Fort Collins—4,990 feet above the sea—helped to increase the evaporation, but tests made upon the Sweetwater reservoir, in southern California, and only 220 feet above sea-level, showed an evaporation of more than 59 inches per year, while the Arrowhead reservoir, 5,160 feet above sea-level, gave but 39.15 inches per year. While the monthly losses showed variations, Mr. Carpenter considers that for the whole year the evaporation, in all probability, is considerably less at high elevations than at low ones.

Measurements on the lakes showed that the results were somewhat larger than indicated by the tank, this being due to the freer action of the air and to the increased surface exposed by the waves, and the principal conclusion arrived at is that the allowance for evaporation in open reservoirs is about 60 inches per year.

Assuming, then, a loss of 5 feet in depth per year, an area of 100 acres would require ¾ cubic feet per second for the whole year to make good the losses for evaporation; one of 500 acres would require 3½ cubic feet per second,—considerably more than would be used to irrigate the whole area.

Mr. Carpenter's paper gives the results of the tests, fully tabulated.

THE BRITISH PRESS

Wasteful Steam Pumps.

THE recent attention which has been directed toward the wastefulness of the auxiliary machinery on shipboard is also revealing similar lack of economy in stationary plants. A paper read before the Municipal Electrical Association, by Mr. J. A. Jeckell, on "Steam-Using Plant" shows that the accepted type of steam pump is indeed a wasteful device.

One pump tested by Mr. Jeckell showed a steam-consumption of 160 pounds per horse power per hour, and another a steam-consumption of more than 300 pounds. "These pumps were the duplex direct-acting, and were supposed to be very efficient, Moreover, these tests were made after the pumps had been thoroughly overhauled by the makers, and been made as good as they could be made; therefore, what must have been the consumption of steam when the pumps had been working some time? It is too awful to contemplate." Some pump-makers are willing to give a guarantee of 50 pounds of steam per pump horse power, but, as a rule, pump-makers are averse to giving an exact guarantee.

The reasons for the wastefulness of these pumps are most evident. In the first place there is little or no expansion, the high-pressure steam following the piston for the full stroke, and then being discharged into the air with a "bark," which tells at once of the wasted energy which it represents. Then again, the duplex type of pump, or, indeed, any type of pump with steam-thrown valves, is most unreliable as to making its full length of stroke, and in many instances working clearances of more than 25 per cent. of the stroke are found. Since there is little or no compression, this clearance space is filled with live steam at every stroke, and the ensuing waste can readily be understood.

For continuously-operating machines like air and circulating pumps it certainly seems as if a really economical driving engine might be installed, leaving the independent devices to be used as emergency apparatus, for use only when absolutely necessary, and upon occasions when economy of steam was altogether a minor consideration.

Twenty Years' Mining Progress.

IN his presidential address, delivered before the Mining Institute of Scotland, Mr. James Forgie reviewed some of the salient features in the progress of coal mining during the past twenty years, and although his remarks referred more directly to mining in Scotland, yet many of the points apply equally well to other parts of the country.

Although twenty years is not a long time in the history of a country, yet when applied to the examination of a single industry it reveals the progress in a marked degree. As compared with England, Scotland has shown the greater development; the output of coal in 1896 in Scotland, showing an increase of 54 per cent. over 1877 as against 45 per cent. for Great Britain, and while the output per man in Great Britain has remained stationary, it has increased in Scotland by 13 per cent.

In looking for the causes of the great development which has taken place during this period we find much of it to be due to the growth of the railway system, and the extension of trade which followed that growth. At the beginning of the period under consideration the coal output simply met the normal demand, and, especially in Scotland, was drawn from the shallower field. The laying off of numerous new collieries and the sinking of deeper pits followed the increased demand, and the output of coal in Scotland, as in Great Britain, has gone on increasing from year to year, although the experience of the coalowner and coalminer, from a financial and wages point of view, has not been that of continued prosperity.

The increased output on the Continent

as well as in the United States, and more recently in Japan, not only of coal, but also of iron and machinery, has gone on to such an extent that these countries can in a great measure meet their own wants, and in some cases are now in the position of being exporters and competitors both in foreign markets and in the United Kingdom.

The advance in the demand for fuel has been somewhat modified by the progress which has been made of late in its economical use, both in the manufacturing trades and also in steamships. The introduction of high pressures and multiple expansion has reduced the coal consumption in the best steam engines to about 1½ pounds per horse power per hour, or less than half what it was at the beginning of the period under consideration.

The real intrinsic value of a ton of coal cannot be estimated from the cost of producing it and the price received for it. When used in manufactures at home—in generating power and for heating, lighting, and many other purposes—its value is far reaching and incalculable, and it will have an increasing value each succeeding year as science and invention find new methods of stripping it of its stored energy. It creates wealth, and provides labour and the necessities of life for a teeming population. When exported, all the value of a ton of coal to the country is simply the miserable price received for it.

In referring to the waste of coal, which is probably greater at the collieries than anywhere else, various plans have been suggested for utilising the very small coal, which, while good fuel, will not pay the cost of transportation. The attempt to manufacture it into briquettes has not met with much success in South Wales, but the plan of burning it in a gas producer to the form of fuel gas, either for transmission and combustion, or for use in gas engines offers possibilities which have as yet not been fully grasped. The mere combustion of the waste coal is not enough, but an outlet for the power thus provided must be made, and this opens up the far larger question of power distribution from central stations to distant points, and its solution is not yet fully accomplished.

Many improvements have been made in the actual working of collieries, especially in the ventilation and in the haulage of the coal. At the surface, also, many improvements have been introduced, including boilers engines, winding ropes, and minor details, but perhaps the greatest improvements has been in the methods of handling the coal and preparing it for the market. Improvements in screening, sizing, cleaning, and washing by the use of elaborate machinery have enabled seams to be worked which would otherwise have remained unworkable, and not only have the lives of many collieries been extended far beyond all expectation but dead and dismantled pits have been resurrected and reworked.

With the improvements in production there has also been a substantial advance in safety to the miners and by extensive legislation and regulation the loss of life has been very materially reduced, so that in every direction, except, perhaps that of commercial and financial prosperity, the coal mining industry has during the past twenty years fully kept pace with the industries of the United Kingdom.

The Liverpool Automotor Trials.

THE trials of heavy automotor vehicles at Liverpool, which are very fully described and discussed in the *Automotor and Horseless Vehicle Journal*, have contributed materially to the knowledge of the capabilities and defects of these vehicles as at present constructed.

Unlike the French "poids lourdes," the vehicles tested at Liverpool were mainly intended for the carriage of merchandise rather than passengers, and all those which made the attempt were of the steam motor type. The full account of the trials, with detailed description of the vehicles and maps and profiles of the routes are so completely given in the account above referred to, that only some general reference to the occasion will be made here.

As might have been expected, the various machines met with numerous difficulties, but on the whole the cause of automobilism as a thing of practical, commercial value, received a distinct impetus.

The trials demonstrated that loads of 5 tons can be moved at an average speed of four miles an hour over steep and badly made country roads at a cost far less than can be done by horses drawing the same load. In some cases the haulage of these loads by horses would require such a number as to make the cost prohibitive, and in no case could a cart horse be expected to maintain a mean speed of four miles per hour for 8 to 10 hours continuously.

The results, accomplished as they were over roads far from satisfactory, should do much to bring this mode of merchandise transport into general use. As the *Automotor* remarks editorially:

"These trials have, in fact, revealed possibilities about road locomotion which even the most sanguine hardly anticipated. They mark the inauguration of cheap internal transport, and the first to avail themselves of the many advantages of motor vehicles for the collection and distribution of heavy goods, will, if our information is correct, be the railway companies."

The principal mechanical defect which the trials developed was the unsatisfactory behaviour of the wheels, and here there is decided room for improvement. "The question of the proper design of wheels is not a difficult one, and the real cause of such failures as occurred seemed to be due to the inability of the designers to grasp the different conditions under which the wheels of an automotor must operate, as compared with an ordinary vehicle.

Most of the makers of motor vehicles cling to the wooden cart wheel, which is essentially a roller, intended to be pulled along by the axle, and receiving its turning force at the circumference. Such a construction is manifestly unfit for transmitting power under the severe conditions existing during the trials.

In such matters it is important that the traditions of the wheelwright be carefully ignored and the wheels, and indeed the entire running gear of a motor vehicle, be designed upon correct mechanical principles, regardless of the contrast which the result may give in comparison with the appearance of the orthodox cart or wagon.

The makers of bicycles have learned to proportion the parts of their productions upon entirely different rules from those still retained by the carriage makers, although there is some evidence that these latter are not above appropriating some of the good points which have thus been worked out for them. So the builders of automotors should strike out for themselves, and leave the old vehicle traditions aside as fully as the constructors of railway carriages have learned to ignore the constructive features of the stage coach. If the Liverpool trials have taught the automotor builders nothing more than this they have done much to advance the cause of motor vehicles, and render the next competition still more successful.

Safety Mining Lamps.

IN a series of papers upon the safety lamp problem, by Mr. H.W. Halbaum, published in the *Colliery Guardian*, the present status of the safety lamp with regard to explosions in mines has been very fully discussed.

The old system, represented by the Stephenson and Davy lamps, was based upon the idea of preventing the flame within the lamp from reaching the explosive gas mixture without. That this most desirable result was in great measure accomplished, is fully admitted, but at the same time the safety lamps constructed on the principle of the obstruction offered to flame by small apertures, or wire gauze, had various defects which have rendered it desirable to find something better, if possible.

In view, therefore, of the desirability of substituting some form of electric lighting in mines, in the place of luminous flames, numerous experiments have been made, with a view of ascertaining the possible danger of ignition of mine gases, either by electric sparks, or by conductors rendered incandescent by the passage of the electric current.

These experiments have been carefully examined by Mr. Halbaum, and in his concluding paper he gives some interesting opinions both as to the various methods of mine illumination and also the extent to

which the laboratory tests represent the real state of affairs likely to occur in a working mine.

In the first place the old form of miner's safety lamp was never intended to enable the miner to remain in an explosive atmospere with impunity for any length of time. The flame of the lamp, indeed, could not pass through the gauze of the Davy and ignite the gas without, but the gas could penetrate within the lamp and burn inside the flame chamber. This at once gave warning to the miner that he had entered into a dangerous working, and also indicated the possibility that the protecting gauze might soon become red hot, and thus ignite the mass of explosive air without. The warning thus given enabled the miners at once to leave the dangerous working and report the condition of affairs without delay.

The weak point of the electric lamp, however well enclosed and free from danger of ignition of mine gases, is the fact that it gives absolutely no indication of the presence of dangerous gases, and is entirely independent of the nature of the air which may be surrounding it.

For this reason Mr. Halbaum strongly advocates the most improved forms of the flame safety lamp, such as the Marsaut or the Mueseler, believing them to be far more desirable than an electric lamp which gives no indication of the presence of gas, and if broken is liable to ignite the mixture without warning.

"Every practical pitman at the present day will admit that the ordinary type of safety lamp constitutes a safety lamp chiefly because it betrays the character of the outer atmosphere. If an explosive atmosphere is present, we do not want a lamp that will burn, and a man that will attempt to work in such an atmosphere. We want a lamp that will give indications of the presence of such an atmosphere, and a man who is not insane enough to attempt to work in an atmosphere which is totally unfit for respiration."

The advocates of the new lamp admit this point by advocating the use of the electric lamp and a separate indicator for firedamp and carbonic acid. This proposal simply nullifies all the advantage claimed for the new lamp, as it requires the Marsaut lamp to be superseded by the electric lamp and also by a firedamp detector which depends for its combustion upon the outer atmosphere, and hence possesses the very faults urged against the Marsaut.

An especial objection to periodical tests of the mine atmosphere is found in the fact that explosive gases are apt to be given off in sudden outbursts, and the great value of the older form of lamp lies in the fact that it gives warning of danger at any time, without involving the uncertainties of "trying" for gas at irregular intervals.

For these reasons, among others, Mr. Halbaum fails to see how the mining fraternity can reap any net benefit from the proposed substitution of the incandescent miner's safety lamps for such satisfactory and well-tried lamps as those known as the Marsaut, the Mueseler, the bonneted Clanny, and several others of equal merit that might be mentioned.

Gas-Works Machinery.

THE general impression made by an inspection of a gas works is anything but favourable to the idea of the use of machinery for the various operations, as the dust, gas, and general deteriorating influences present appear to be such as to prevent the use of any but the coarsest and roughest kind of machinery. The work must be done, however, and, if the conditions are such as to make it hard upon machines, and, of course, still harder upon men, this kind of labour ought to be saved, if possible.

In a paper presented before the Society of Engineers, Mr. Edward Alfred Harman describes very fully the machinery used in gas works.

"Gas-works machinery has to deal with numerous combinations of unpurified gases, acids, alkalies, gritty and impure water, oils, and spirits. Some of the machinery is required to draw out hot coke from benches of ovens at a distance of from three to four feet from them; while the machines are subjected to all the in-

fluences of heat from the furnaces and material they are employed upon. The machinery, therefore, is not working under the same conditions as at other engineering works, where most of the influences named are absent. To meet these special requirements, necessity and experience have designed a whole collection of machinery, which possesses distinct features of interest and importance."

While the manufacture of gas is primarily a chemical operation, there are so many mechanical features about that it is also a manufacturing process.

One of the most important pieces of gas-works machinery is the exhauster, the function of which is to reduce the pressure upon the dip pipes,—not as is generally supposed to draw away the gas directly from the retorts. This relief of resistance cannot draw air in from the retorts, as is sometimes erroneously assumed, since the dip pipes are fully sealed, but it does prevent the accumulation of back pressure in the retorts. Back pressure is objectionable for several reasons. Besides facilitating the production of a hard carbon deposit upon the sides of the retort, it also detains the gas in contact with the incandescent coke, thereby causing serious decomposition.

The exhausters also act as force pumps, to deliver the gas into the holders, the lightness of the gas being by no means equal to overcoming the resistance offered by the weight of the huge masses of framework and sheet metal.

The exhausters are usually driven by steam power, but Mr. Harman makes a good point when he says that gas engines should be used for this and other power service about a gas works. It is, indeed, somewhat of an anomaly to be generating steam, necessitating powerful boilers, when an ample supply of gas power is always available.

In the handling of coal and coke there is room for much labour-saving machinery. Coal-stacking machinery is fully reviewed in Mr. Harman's paper, especial attention being called to the installation at the Copenhagen gas works, and the coke conveyors at Birmingham and at Bruges.

The coal transporters used are mainly of the cantilever type, with traveling bucket, while the coke conveyors are made with endless bucket chain, which delivers the quenched material to a revolving drum screen, beneath which the wagons are placed to receive the various sizes as they are delivered.

Power-charging machinery is now in use for delivering the coal to the retorts, each machine having an adjustable hopper, provided with a feeder box for regulating the weight of the charge of coal. The charger consists of a scoop and carriage, the latter containing the apparatus for emptying the coal out of the scoop. The scoop enters each retort twice in making a complete charge, the coal being thrown alternately on each side of the retort. The power-charging machine is fitted with propelling gear, and arranged to travel up and down the retort house.

Drawing machines are also used, being arranged with rake bar provided with raising, lowering, and traveling gear, usually operated by compressed-air cylinders.

It is a question in Mr. Harman's mind whether in view of the efficiency and capacity of modern stoking machinery, there is any room for economy by use of the more recent invention, or re-introduction, of inclined retorts. With the existing machinery a retort may be discharged and recharged in a few seconds with comparative ease, and this can hardly be improved upon by the use of the inclined retorts.

There is still room for the exercise of much mechanical ingenuity in the reduction of wastes in gas works. In spite of the reduction in time by the use of machinery instead of hand-charging, a large quantity of gas is wasted. The recovery of the spent lime is also a field for investigation; while the possibility of compressing the coke dust into briquettes should not be overlooked.

The waste water from the sulphate-of-ammonia manufacture deserves consideration. It now passes away hot, and amounts to millions of tons annually, representing a waste of energy in the

form of heat which is certainly preventable. An enormous amount of cyanides in coal gas is also being lost, although efforts are now being made to recover it.

The whole development of gas-works machinery is now rapidly passing from the early rule-of-thumb stage to the domain of scientific engineering, and the results cannot but prove satisfactory alike to engineers and gas-works managers.

Steam Laundry Machinery.

ALTHOUGH machinery has been used for a long time for cleansing fabrics in the factories during the operations of the original manufacture, it is only recently that they have been used in connection with laundry purposes. From this we may except the well-known mangle, which is of mediæval origin, the name being derived from *maganon*, in the same manner as the military "mangonel."

A very full account of modern laundry machinery is given in a paper read before the Institution of Mechanical Engineers by Mr. Sidney Tebbutt, and published in *Engineering*.

Mr. Tebbutt gives the French the credit for being the pioneers in this field, although it is almost entirely from the United States that the present machines come.

From the obvious conditions of the work, the machinery for use in laundries must be constructed with the utmost care to provide against wear and tear of the articles upon which the work is done, and it must also be simple enough to be readily handled by untrained labour. Every provision must be also made for speedy repairs or renewals of important parts, as the nature of the work demands freedom from interruptions or long stoppages.

Laundry machinery can be broadly divided into that which cleanses and that which finishes.

The cleansing machinery requires the use of much hot water, and as all the heating of washing liquors is accomplished by turning the steam into them direct, it is very important that the steam should be free from grease and other impurities. It is therefore desirable that the exhaust steam from the engine which drives the machinery should be used for some other form of heating, such as drying coils, or the like, and no exhaust steam permitted to re-enter the boiler.

Much care should be taken with the valves and piping, as there is often much loss from leaky pipes and fittings, while the constant use to which the valves are subjected soon gets them out of order if they are not thoroughly well made in the first place.

The methods of washing vary in detail, but involve the same general principles. The clothes are soaked for a time in cold water containing a little soda, then again in water warmed to about 100° F., after which a third solution of soap and soda at about 130° F., is used. The mechanical portion of the operation generally consists lifting the clothes a certain height out of the water and then allowing them to fall into it again. This is accomplished by the use of an outer cylindrical casing partly filled with water, within which is a revolving cylindrical cage in which the clothes are placed. The hot washing liquid can flow through the spaces between the bars of the revolving cage, and the direction of revolution being continually reversed the desired action is readily obtained. These machines are generally made entirely of wood secured with brass wood screws, in order to avoid the formation of iron rust or mould.

The supply of steam and water and liquor is introduced into the ends of the outer cylinder, and in some forms of machine, circulating devices are provided to compel a flow from the outer to the inner case and round again to the outer casing.

Similar machines, made entirely of metal are also used to be operated with steam at a pressure above that of the atmosphere, and these are supposed to be more efficient than the low pressure machines, as the high temperature effects a more thorough cleansing, besides disinfecting the articles. At the same time excellent results are obtained with the atmospheric machines, and thousands of them are in daily use.

The drying is performed in the first stage by centrifugal extractors, after which the articles are generally passed to a drying

room either provided with steam heating coils, or through which air is forced by means of a blower, after having first passed through an exhaust steam heater. Some articles are ironed at once when taken direct from the centrifugal machines.

The finishing machines used in laundries include the various machines used for ironiug, of which there are a great variety. They all act mainly in the same way, although they differ greatly in design and capacity. In nearly all there is a hard polished surface of metal, which is heated by steam or electricity; and a second hard surface of metal or wood, which is padded over with laters of felt covered with a wrapper of cotton sheeting. The padded surface holds the article which is being ironed, so that it can be made to rub against the polished heated surface, while allowing for irregularities of thickness in the article itself. Mr. Tebbutt gives detailed descriptions of the most important ironing machines at much greater length than is here possible, and much mechanical ingenuity has been expended in this direction.

The whole subject of laundry machinery is one which will well repay investigation, and the skill of the engineer will find it a fertile field for the exercise of inventive ability.

The Duty of the Consulting Engineer.

AN interesting question has recently arisen concerning the extent to which the consulting engineer should feel bound to consider the interests of others than his immediate clients when reporting on technical subjects connected with the promotion of joint-stock companies, and an editorial and some correspondence in *The Engineer* contain some comments worth considering.

When an invention has been brought to the point of mechanical success and the financial promoter is called upon to launch it in the commercial world, it is generally necessary to have a report upon the matter by some consulting engineer of reputation, and upon his report prospectus is usually framed, so far as the merits of the device are concerned. It is frequently found that the opinion of the engineer is of importance in points decidedly beyond the mere mechanical features of the project.

"It is not every excellent invention which will bring in money. It is not every scheme for a harbour, a dock, or a railway that possesses commercial worth commensurate with its engineering merits; and the man who can recognize the truth in this way is able to do service as a consulting engineer, of infinitely greater importance than the man who can only say whether a given scheme can or cannot in his opinion be carried out."

In the case under discussion one of the most prominent consulting engineers in Great Britain included in his report upon a mechanical device an opinion regarding the validity of the patents, this being a feature which was not acceptable to the promoters of the scheme, however desirable a warning it might have been to intending investors. The result was not altogether satisfactory to the managers of the company, but the engineer objected to the publication of extracts from the report, and insisted that it must be used as a whole, or not at all.

It appears that the engineer held that the expert, in making a report, is bound to make himself master of the whole subject, and that he will not have discharged his duties unless he places all the information he can obtain in the hands of his employers. He must tell not only the truth, but the whole truth. The great body of experts will probably hold that this is going too far, and, indeed, in the correspondence which the matter has elicited it is maintained that there is no good reason why the consulting engineer should transgress the well-known rules of practice of the profession, and do much more than he is called upon to do.

The engineer who is called in to report upon the construction of a proposed railway is not expected also to report upon the question as to the commercial value of the scheme; that is left for other specialists to determine; and, so far as the interests of the prospective shareholders

are concerned, they must be protected by others than the engineering fraternity, principally by the rule of *caveat emptor*.

In regard to the case at issue, it is also a question whether an *ex-parte* opinion regarding the validity of patents, by one to whom all the information on that part of the subject has not been submitted, is proper matter to be incorporated in a report upon mechanical features.

In most cases such a matter requires the skill and research of the specialist in patent investigation, with a knowledge of existing precedents and decisions, and for the engineer to assume, uncalled upon, that it is his function to include in a mechanical report matters which clearly belong to another phase of the subject, and to insist that this irrelevant matter must be quoted along with the opinions upon the mechanical features, is, to most minds, an unwarrantable extension of the functions of the consulting engineer.

The Paris International Exhibition.

IN view of the peculiar conditions affecting exhibitors at the coming exposition at Paris, an editorial in a recent issue of *Engineering* contains some very pertinent remarks.

In the first place it is understood that the system of classification is such that it is quite possible—even probable—that an exhibitor will not be able to keep his exhibit together as a whole, but be compelled to divide it and scatter it among various buildings. This system of grouping like products together will doubtless contribute very largely toward the unity of group exhibits, and add much to the educational value of the exposition, but it will be a matter of much inconvenience and additional expense to the exhibitor.

One thing is very apparent, even at the present stage of affairs, and that is the fact that the competition is to be, not between individuals, or firms, but between nations, and the exhibits of each country, considered as a whole, are to be pitted against those of rival nations. "For this reason," as H. R. H. the Prince of Wales said, in his address to the Royal Commission, "the display of similar or identical objects by different exhibitors should be avoided as much as possible, and efforts should be made to secure variety with a view of making the most of the space available. It is difficult to avoid some duplication when several manufacturers of similar articles wish to show their goods, and it would be invidious to give the preference to one out of many, but it ought not to be impossible either to form joint exhibits, giving as complete a representation as possible of particular industries, or for manufacturers to come to some agreement among themselves which would bring about the same result. Such a plan, though it might call for some self-sacrifice on the part of individuals, would secure a degree of completeness which could not otherwise be attained, and would go far to promote the common interests of the industry as a whole."

As *Engineering* well remarks: "The great inducement to exhibit—of making trade, and securing awards—must become secondary incentives. Commercial enterprise must give place to patriotic desire to show a united front against foreign industrial enemies, and British manufacturers must fall into line—the German line—and accept the system of exhibiting by collectivities. If this can be done there need be no fear of the result. Time will show whether it is practicable."

THE CONTINENTAL PRESS

The Theory of Retaining Walls.

ALTHOUGH the subject of retaining walls and the proper proportions which must be given to resist a given earth thrust has been discussed by many writers and is embodied in most treatises on civil engineering, practice has shown that the results are not always satisfactory. This may be due to defects in the theory, or more probably to the existence of conditions which the theory has neglected to take into account, but which persist in making themselves felt in actual practice.

For these and other reasons, Herr Iszkowski has reëxamined the subject, and contributes what he terms a "rational" theory of retaining walls to the *Oesterreichische Monatschrift für den Oeffentlich Baudienst*. Some of the points made will bear consideration.

The fundamental question involved is that of the actual pressure exerted by the earth, and it is usually this which is made the subject of assumptions not in accordance with the actual facts. Instead of being a solid prism, acted upon only by the force of gravity and the resistance of friction upon its surface, the nature of the earth enters largely into the manner of its action in sliding or breaking.

The angle of repose of loose earth can readily be determined for any given nature of material; but, when a bank slides or breaks down under the pressure of earth behind it, the angle of rupture is different from the angle of repose, and in many cases the surface is not that of a straight slope, but, rather, a concave break, usually of the same form and curvature for the same materials.

Taking these facts into consideration, Herr Iszkowski deduces a formula from which the angle of rupture can be computed for different kinds of earth under the varying conditions of actual practice, and a table enables the more usual angles to be taken at once.

The paper is a valuable addition to the literature of the subject considered on its theoretical side, but, as a matter of fact, the chief difficulty in the application of any such method of computation is the fact that the nature of the filling behind a retaining wall is rarely known at the time the wall is designed, the wall generally being constructed first and then filled with any loose material which may be available. Therefore computations based upon the specific gravity of the backing and its angle of slope can be considered only as approximate, and a large margin must be allowed for a material which may at times be almost liquid and at others frozen into a mass, like rock.

Electric Motor Plows.

SEVERAL months ago we referred in these columns to the introduction of electric motors for the purpose of operating agricultural machinery, and now we have to note a very full account of improved devices for this purpose in an article by Dr. Müllendorf, in the *Elektrotechnische Zeitschrift*.

The general principle upon which electrically-driven plows are operated is not greatly different from the well-known Fowler system of steam plowing, in which a gang plow is hauled across the field by a cable operated by a portable engine. In the electric system, however, the motor, instead of being a portion of the stationary mechanism, is mounted on the plow, and travels with it.

Instead of a cable, the motor acts upon a chain, secured at each end to traveling anchorages on each side of the field, the chain passing around a sprocket wheel geared to the motor upon the plow. The mechanical details of this portion of the mechanism are readily understood, and very simple. As each furrow is traced, the anchorages are moved forward, and the reversible plow is started on the return travel.

It necessary, however, to provide some

means of conveying the current to the travelling motor, and it is in this portion of the operation that room for ingenuity is offered. Any system must be simple enough for use in the rough surroundings of open farm work, and any desired field must be readily and fully covered at a moderate cost, if the system is to compete either with steam or animal power.

In the Zimmermann system, shown in the journal above cited, the two wires are carried across the field by the side of the path of the plow, trolley arms reaching out to make the contact. The wires are supported at intervals upon ingenious travelling supports, which reach out and hold the wire from above, allowing free contact to the underrunning trolleys, which are of the sliding variety.

The wire supports are low, as there is no occasion to provide head-room beneath them, and are provided each with one sliding foot and one roller. This permits them to remain steady during the passage of the plow, as the direction of its motion is at right angles to the roller, while, when the anchorages are shifted, the supports are readily shifted with them, as the conducting wires are kept taut. A simple system of poles extending over the boundary lines of the farm and connected with the power station enables this little temporary trolley line to be connected for any field very readily, and the anchor cars are provided with reels of trolley wire to enable fields of any reasonable width to be spanned.

There is a manifest advantage in having the motor mounted on the plow, as it is there entirely under control of the man on the plow, who can regulate the motion according to the demands of the situation. In this respect it is superior to the steam plow, bearing much the same relation to it that the electric motor car does to the cable tram, the former having control of its motive power to a much greater extent than the latter.

The cost of plowing by electricity is, of course, the item which will control its introduction. Figures are given as to the cost of the original plant and that of operation, but these are of little comparative value at present. The real advantage of any such system must lie in the operation in connection with a central power station from which numerous users draw current. Where a convenient source of power is available and current can be supplied to a number of agricultural establishments for all power purposes, as well as lighting and possible heating, the electric system of plowing will undoubtedly come into extensive use. Indeed, the advent of the electric plow may help to bring the attention of agriculturists to the widening scope of electrically-transmitted power, and lead them to become interested in schemes for bringing current to their neighborhood. The introduction of the electric motor on the farm will undoubtedly come with increasing appreciation of the advantages of available power and light at all times.

Ship Models and Experimental Tanks.

THE importance and value of tests made upon models of proposed vessels in experimental tanks is conceded by all shipbuilders, and, notwithstanding the expense of the apparatus involved, the information obtainable in this manner is held fully to justify the cost.

Most of the study which has been given to the subject, however, has been devoted to the relations which the performance of the model bears to that of the full-sized vessel, and, since the original experiments of Froude, and the formulas deduced by him, the mechanical features of such testing-tanks have been improved mainly by the introduction of recording devices, which enable all the elements under observation to be obtained automatically.

Some interesting tests have been made recently by Professor Engels, of Dresden, upon the influence which the form of the channel has upon the speed of the model, or, rather, upon the resistance which is opposed to its motion, and a discussion of his experiments is given by Herr Schromm in the *Zeitschrift des Oesterr. Ingenieur und Architekten-Vereines.*

These tests show clearly that the shape of the tank has an important influence upon the results of the tests, and that, i

tests made upon different tanks are to be at all comparable, the channels should at least be of similar section, while, if the test speeds are to be used for deduction of results to be expected in open water, a correction factor should be applied, this correction having been determined for the tank upon which the trials were made.

Professor Engels used a single model upon a tank the shape of whose channel could be altered, and, by making a number of tests at various speeds upon each form of channel, he obtained data for the construction of speed curves. The result showed that the curves differed for each shape given to the cross-section of the channel, all other factors having remained constant.

Apart from the important bearing of this fact upon the conclusions to be drawn from model trials, it brings up the subject of the best form for the cross-section of ship canals, so far as the production of the minimum resistance to the progress of the vessels is concerned.

When the size of the channel is very large, compared with the immersed section of the ship, of course the shape or slope of the sides is a matter of comparatively small influence upon the resistance; but, in the case of most canals, where there is only enough width to permit two vessels to pass each other, the slope or shape of the sides produces an important effect, especially as the speed of the vessel is increased.

Hitherto the shape of the banks has been controlled principally by constructive conditions, and in many cases these must still be given predominant influence; but, in view of these recent investigations, it is probable that future works of this sort will be somewhat modified.

The Testing of Lubricating Oils.

A NUMBER of devices have been made for testing the lubricating value of different oils for mechanical purposes, most of these being adapted for journal bearings and similar service. A new oil-testing device is described in an article by Dr. Sigmund Kapff in the *Zeitschrift des Vereines deutscher Ingenieure;* it is especially adapted for investigations with small high-speed spindles, such as are used in many forms of spinning machines, and, on a larger scale, in some forms of wood-working machinery.

The apparatus of Dr. Kapff is made without belting or gearing, the vertical spindle being driven by a small electric motor, at speeds as high as 8,000 revolutions per minute, while any desired pressure can be brought upon the step-bearing on which the spindle rests. Any desired lubricant may be used, and the work due to the friction is indicated at any instant by the amount of current required by the motor. The spindle is entirely surrounded by an oil chamber, and this again is enclosed in a jacketed cylinder which prevents the escape of heat, while a thermometer is inserted so as to indicate the rise in the temperature of the bearing for any known conditions.

With such an apparatus many properties of lubricating oils which are not readily indicated by other testing devices can be determined. Many oils which show excellent results at moderate speeds begin to work badly at 3,000 revolutions, and at higher speeds the lubricant appears to be thrown entirely away from the bearing, and a greatly-increased frictional resistance appears.

By plotting the quantities of power consumed as ordinates, and the velocities as abscissas, curves may be constructed for various oils; Dr. Kapff gives a number of such curves, with comments upon the behaviour of the lubricants. As might be expected, the higher speeds require oils of greater viscosity than is needed for lower speeds, but this is correct only within certain limits. By taking successive mixtures of petroleum and spindle oil, so as to produce a progression in viscosity, it is shown that beyond a certain point an increase in viscosity requires an increase of work to overcome the friction. The minimum resistance appears with a mixture of 12 parts of petroleum to 88 of spindle oil, and at 4,100 revolutions per minute the gradual diminution in resistance from the successive changes in percentages is shown by the diagram to cease at the above pro-

portion, the curve then taking an abrupt upward turn, showing the increase in resistance as a pure spindle oil is reached.

The paper contains many interesting details concerning the machine and the method of testing, and with machinery involving the use of high-speed spindles there is no doubt that much advantage would accrue from a systematic testing of the oils.

It is undoubtedly poor economy to save a large percentage in the cost of a small quantity of lubricant and add a material proportion to the friction and fuel account, and, since, in connection with this, there is a possibility of material injury to the working parts of valuable and delicate machinery, the cost of careful testing may pay for itself many times over.

The Determination of Moisture in Steam.

WITH the increasing attention being given to the performance of engines and boilers, the quality of steam supplied by the one and used by the other has received its due share of consideration. The evaporative performance of a boiler cannot be compared with that of any other boiler, unless the percentage of entrained water in each case is accurately known; any test of the quantity of steam required per horse power by an engine must include also a knowledge of the quallty of the steam thus used.

Various methods and instruments have been devised for determining the quality of the steam, but many of these are described only in passing publications or buried in the transactions of professional societies. The whole subject is now reviewed and discussed in a series of articles by Herr Ernest Brückner, in the *Zeitschrift des Vereines deutscher Ingenieure*, wherein the various devices proposed and used in different countries are described and illustrated.

The earliest experiments in this direction were made by Hirn and his associates, Hallauer and Leloutre, the method used being that of the condensation of the steam in the so-called "continuous" calorimeter. At first rather discordant results were obtained. After further experience, Hirn stated that the attainable limits for dryness of steam were between 2 and 5 per cent. of moisture. The subject was promptly taken up by Thurston in Americs and by Unwin in England, and within the past few years much attention has been given to it, especially in the United States, as the *Transactions of the American Society of Mechanical Engineers* show.

After discussing the various causes which may lead to excessive foaming in steam boilers, Herr Brückner proceeds to examine the principles involved in the various methods of determining the quantity of moisture.

The chemical method, in which a known quantity of a suitable salt is dissolved in the water and the proportion of the salt found in the steam measured, is examined, and rejected as lacking in precision.

Before entering upon the discussion of mechanical methods, the conditions attending the formation of watery vapor in steam are examined, and the influence of surfaces of contact and small apertures is taken into consideration. The thermodynamics of an expanding jet is then taken up, and also the construction of mechanical separators, after which the well-known calorimeters of Barrus, Peabody, Carpenter, and others are illustrated, their application being shown. The manner of distribution of moisture in steam pipes is also considered, and the proper method of tapping the connections to the instrument is shown, so that a representative sample of steam may be examined, and the importance of this and similar details of observation is shown.

In summing up, Herr Brückner concludes:

(1) In any test of a steam plant an investigation of the quality of steam must be made, if reliable and satisfactory knowledge of the efficiency is to be gained.

(2) In determining the presence of moisture in steam great care must be taken to make the test while the plant is working in normal condition. The boiler should be fed with clean water, and anything which might cause foaming should be avoided; valves should be opened slowly,

and sudden fluctuations in the use of steam as well as sudden changes in boiler pressure, should be avoided. Also care should be taken that even firing is secured.

(3) The value of the existing methods of determining moisture varies. Chemical methods are not to be recommended, and steam separators give results which, while fairly reliable, are not sufficiently precise for scientific purposes. The condensing calorimeter is also unreliable, even when the greatest care is exercised, and if it is used, the continuous form is to be preferred. Either the superheating or the throttling calorimeter is to be recommended for accurate work, but care should be taken to have high-grade thermometers and accurate pressure gauges, and the various sources of error should be thoroughly investigated and the necessary corrections computed.

The examination of the entire subject in Herr Brückner's paper is well worthy of perusal and many of the points made by him are eminently practical, and the discussion which he gives should have the result of attracting renewed attention to this very important feature in the testing of steam plants.

Progress in the Study of Steel.

THE term steel has always been more or less indefinite in meaning, so that it is generally considered necessary to add some qualifying adjective, in order that the nature of the material under consideration may be understood. Within recent years, however, the causes of the differences between various kinds of steel have been studied in a manner which has enabled metallurgists to speak with some degree of precision concerning them.

An interesting paper upon the progress made in the knowledge of the constitution and characteristics of steel was presented at the meeting of the Association of Engineers of the Academy at Liége by M. Ad. Greiner, the manager of the Cockerill works at Seraing, and has been published in the *Revue Universelle des Mines.*

After referring to the importance of a thorough knowledge of the internal constitution and nature of the metal, M. Greiner divides the various methods of investigation into three groups:

(1) Chemical;
(2) Mechanical;
(3) Metallographical.

Examination by the chemical method involves two difficulties which may lead to error,—one the difficulty of securing a representative specimen for analysis, the other the difficulty of obtaining a sufficiently accurate analysis within the limits of time and cost imposed by manufacturing and commercial conditions. At the Stockholm congress in September, 1897, efforts were made to have a central laboratory established in connection with the Polytechnic School at Zurich; although the plan met with some opposition, and has not yet been entirely carried out, there is every prospect that such a central laboratory will soon be established.

The method by mechanical test is the one which has been longest in use, and much valuable information has been gained by it. The greatest difficulty with it has been the lack of uniformity in methods and records.

It was to obviate this difficulty that the International Association for testing materials was organized, whose work, at and between the four triennial congresses thus far held, has been devoted to this end. It is not intended to limit the work of various investigators to narrow or irksome rules, but rather to indicate such uniformity in the preparation of test pieces and methods of observing and recording tests as to make the work of students all over the world comparable, and thus render every observation a contribution to the general advance of the science.

By far the most rapid advance has been made, however, in the comparatively new method of metallography, which includes the examination, microscopical or otherwise, of the physical structure of the metal, the study generally being aided by etching the surface, in order to bring out the configurations more clearly.

By the use of the method of metallography many perplexing points in connection with the behaviour of steel and other metals have been either explained or indi-

cated. In one case, noted by M. Ast, two sets of rails placed in the same line of track, passed over by the same trains under the same conditions, showed marked difference in wear, although under mechanical and chemical tests they seemed to be composed of precisely the same material. It was only by treatment with acid, and a microscopical examination, that a marked structural difference in the steel of the two sets of rails was revealed. A simpler and more convincing proof of the value of metallography could hardly be cited.

It is this question of structural change which is leading to some knowledge of the actions that take place in the operations of hardening and tempering, and there is every prospect that these important processes will be entirely removed from their present empirical position, definite scientific knowledge replacing the arbitrary recipes and formulas now cherished as workshop secrets.

One of the most valuable features of metallography lies in the readiness and accuracy with which the results may be recorded by photography, this fact making it especially practicable to compare records made at distant points and long intervals of time. M. Greiner gives a number of illustrations of photo-micrographs of various steels and alloys, which illustrate his points very fully, and at the same time bear witness to the value of photography and photo-engraving in this connection.

Altogether, much of the mystery which has surrounded the structure and behaviour of steel bids fair to be cleared up before these modern methods of investigation, so that greater uniformity in product and greater certainty in use may fairly be predicted for the future.

Test of a Heavy Cable.

TENSION tests of wire cables are by no means rare, and, as a usual thing, attract but small attention; but, when a cable of 90 millimetres diameter (3.6 inches) is submitted to the action of a 500 ton testing machine, the record of the result is interesting, even though the specimen was not actually pulled apart.

The illustrated account of the test is given by Professor Martens in the *Mittheilungen aus den Königlichen Technischen Versuchsanstalten*, the tests having been made at that institution by Professor Martens himself, in the great machine of his own design.

The cable, which was made by the St. Egid Iron and Steel Company, was composed of six main strands twisted about a core of tarred hemp rope. Each main strand consisted of six secondary strands also twisted about a hemp core, the secondary strands each containing 30 steel wires of 1.46 millimetres (0.0576 inch). There were thus $6 \times 6 \times 30 = 1{,}080$ wires, with a total cross section of 1,808 square millimetres (2.8 square inches). According to the requirements of the manufacturers, the wire in the cable was to have a breaking strength of 185 kilogrammes per square millimetre (about 260,000 pounds per square inch).

As might well be expected, the principal difficulty in connection with such a test lay in the securing of the cable to the heads of the testing machine so as to prevent slipping, and at the same time avoid crushing or otherwise deforming it to an extent which would interfere with the reliability of the test.

Two methods were adopted, one end of the cable being passed around a heavy cast-iron dead-eye, and the end spliced back into the main cable, while the other end was passed about a similar dead-eye and laid back parallel to the main cable, three sets of iron clamps being used to hold the two together. The clamps were channelled out to receive the cable and hold it without crushing, and it was expected that the three sets of clamps would be capable of holding against any pull necessary for the test.

Much trouble was experienced with these clamps, as the dead-eye turned in the cable, owing to the slipping of the clamped portions, and rendered several trials necessary. Finally, under a total tension of 250,000 kilogrammes (550,000 pounds), a number of the wires in the main body of the cable broke, and at the same time two of the main strands at the throat of the splice parted. Observations

made of the dimensions of the cable as the tension was increased showed a gradual diminution in diameter, the reduction being from 92 millimetres at the start to 80 millimetres under a tension of 150,000 kilogrammes.

Dividing the total breaking load by the actual cross-section of wire in the cable, we have a breaking strength of 138 kilogrammes per square millimetre (about 196,000 pounds per square inch), or about 75 per cent. of the required test strength of the single wires.

The article shows photographic reproductions of the cable in the testing machine, and these add much to the interest of the account. Altogether, the results form a remarkably good showing, especially for a cable of such dimensions; and both the cable itself, and the machine in which it was tested, are noteworthy contributions of Germany to industrial products.

Heavy Automobile Vehicles.

THE general idea of an automobile is that of a pleasure carriage, such as a motor tricycle, and the principal efforts of designers have been directed to the production of a vehicle either for private use or possibly for city cab service.

The results of the trials of the so-called "poids-lourdes" in France have been to direct attention to the possibilities of these heavy road motor vehicles, and the success which has attended them, especially in France, may lead to their adoption elsewhere, as soon as local official prejudice can be overcome.

Among the best known of the general road automobiles those constructed on the Scotte system are included, and the fact that a regular omnibus service has been maintained between Courbevoie and Colombes for more than a year is evidence of the practical nature of these vehicles.

A full description of them is given in a recent issue of *La Revue Technique*, with plates showing the construction in detail. There is nothing particularly novel in the design, the Scotte automobile being simply a well-planned steam omnibus for use on thoroughly good roads, and the success of the machine is owing rather to the general good judgment which has been displayed in adapting steam for the service than to the display of any especial inventive ability.

Steam is furnished by a vertical boiler of the Field type, not unlike some which have been used for steam fire engine purposes, a special form of hood being arranged to prevent cinders and sparks from being discharged in an offensive manner. The engines are placed beside the boiler, there being two vertical cylinders, and the motion being transmitted by double chain gearing to the drivers.

One chain transmission connects to an intermediate shaft, from which independent chains and sprocket wheels transmit the motion to the drivers. A "jack-in-the-box" gearing system is contained in the hub of each driving-wheel, enabling change of speed to be obtained, and the connections are so arranged that the speed can be varied for both wheels simultaneously, or for either independently, thus giving special facility of control for curves of short radius.

The steering is effected by turning the wheels of the rear axle each on its own swivel, the two being coupled by rods to a screw operated through bevel gears and shaft, by a convenient hand wheel.

Although there are a number of seats in the motor vehicle, the Scotte system includes the hauling of a trailer omnibus, and in some instances of a merchandise wagon, the whole forming a train capable of moving on ordinary highways at a speed of six to seven miles an hour. It is not intended to offer inducements for pleasure travel, the system being designed expressly to enable many parts of the country now out of convenient reach of railway communication to be placed in connection with cities and commercial centres and given facilities which otherwise they would not possess.

The principal criticisms to be made on the system are the low limit of speed and the large combustion of fuel. The latter doubtless will be reduced with improved engines, but the former is governed rather

by the conditions of the roads, and the general necessities of the case, than by any features of construction of the machine.

Such a system may be of service in France, but it is hardly likely to come into vogue either in England or America. In the United States the rapidly-extending use of trolley electric tramways as feeders to the main railway stations has shown an acceptable and convenient method of solving the problem of putting the outlying country districts into communication with the commercial centres, and the same will doubtless come into use in England, as occasion may demand, rather than any system of slow steam trains on common roads.

The Heat Balance of the Blast Furnace.

WHEN we consider the apparent simplicity of the operations performed in an ordinary blast furnace, it seems as if the chemical and thermal reactions involved should long ago have been fully understood and recorded. As a matter of fact, however, metallurgists are by no means united as to the exact conditions which obtain, when, by the action of heat and blast, a mixture of coke, ore, and flux is converted into metallic iron, slag, and gas; and on many points the authorities still agree to disagree.

A very thorough discussion of the subject, by M. G. Rocour, appears in the *Revue Universelle des Mines*. The paper was presented among the technical discussions at the semi-centenary of the Association of Engineers of the Mining Academy of Liége, and in it the views of the most prominent writers are compared and reviewed.

The chemical side of the process is fairly well settled, and M. Rocour devotes himself mainly to an analysis of the thermal reactions and to an effort to establish the heat balance which must exist during the operations of smelting. After a brief review of the theories of Tunner, Lowthian Bell, Gruner, Ledebur, and others, M. Rocour refers to the important relation which the thermo-chemical researches of Thomsen, Berthelot, and Mahler bear to the subject, in that they enable the calorific value of the various materials under discussion to be determined and the heat exchanges computed. The data for these researches he has gathered from various sources. Some very complete records were obtained from the Jarville furnaces, in Belgium; others from furnaces in the Cleveland district, by Bell; and still others from furnaces in the Saar district, by Jung, Thielen, and Schinz. Data are also given for the Lucy furnace at Pittsburg.

By computing the total quantity of heat furnished, in calories, from the fuel and in the hot blast, and balancing against this the number of calories required to accomplish the reactions produced in the reduction of the iron, the thermal efficiency of the furnace can be calculated, thus enabling the economic performances of various furnaces to be compared on a thermal basis.

This M. Rocour has done in a number of cases, and his paper contains numerous examples fully worked out in detail, in such a manner as to enable any intelligent reader to apply the method to other cases. The efficiencies of the furnaces tabulated in the paper range from 52 to 66 per cent., including heat utilised by the blast.

The thermal exchanges occurring in the different zones of the furnace are also discussed, and graphical diagrams are given, deduced mainly from the observations of Schinz, examined by the methods of M. Rocour; and the subject of the possible methods of obtaining the greatest amount of energy from the discharge gases is examined in connection with the composition of the gas products under different conditions of furnace performance.

While there are other considerations than those of the highest thermal efficiency which must be considered in making up the commercial efficiency of a blast furnace,—the quality of product, the relation of output to fixed charges, and similar points having always to be considered,—from a metallurgical point of view the thermal analysis which M. Rocour has given in this important paper will be found most interesting, and its relation to the general economical performance is undoubted.

THE ENGINEERING INDEX

INTRODUCTORY

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London
Cosmopolitan. *m.* Irvington, N. Y.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Apartments.

Architecture of Apartment Buildings. Irving K. Pond. Presents various types for comparison and for contrast, discussing arrangement and conditions. Plans. 2400 w. Br Build—June, 1898. Serial. 1st part. No. 21222 C.

Balcony.

A Monolithic Concrete Cantilever Balcony. Illustrates a balcony of concrete and twisted iron, projecting 4 ft. and carrying a uniform load of 400 lbs. per sq. ft. 500 w. Eng Rec—June 18, 1898. No. 20939.

Bristol, Eng.

The Ancient City of Bristol, England. Arthur Lee. Illustrated description of many of the ancient buildings. 1500 w. Stone—June, 1898. No. 21214 C.

Cement Construction.

The Record Storage Building of the Discount Bank of Paris, at Rueil. (Les Archives du Comptoir d'Escompte de Paris à Rueil.) Illustrated description of an interesting storage building in cement and steel construction, especially arranged for the storage of papers and documents. 1000 w. La Revue Technique—May 10, 1898. No. 21010 D.

Exposition.

Review of the Works of the Exposition. (Revue des Travaux de l'Exposition.) An excellent illustrated description of the present condition of the work upon the buildings for the exposition of 1900, devoted to the buildings in the Champs Elysées. 4000 w. Le Génie Civil—May 28, June 4, 1898. Two articles. No. 21004 each D.

Fireproofing.

Fireproof Construction. A. L. A. Himmelwright. Reprint from the *The Polytechnic*. Considers particularly the fireproof floor construction, and the protection of the steel skeleton frame of buildings. 3000 w. Arch & Build—May 28, 1898. No. 20532.

The Buck Building, New York City. Illustrates a very narrow tall building for light manufacturing having unusual features in the foundations and columns. 700 w. Eng Rec—June 25, 1898. No. 21165.

Foundations.

A Brick and Iron Foundation for a German Building. Describes a spread foundation for a soil carrying but 3200 pounds per square foot. 600 w. Eng Rec—June 4, 1898. No. 20649.

Exchange Court Building, New York City. Describes and illustrates the pile and cantilever foundations of a 12 story office building. 500 w. Eng Rec—June 11, 1898. No. 20806.

Foundations as Applied to London Buildings and Riverside Foundations. A. T. Walmisley. Read at meeting of the Architectural Assn., London. Observations on the subsoil of London, with particulars from named localities, and the systems in use. Discussion. Ill. 16000 w. Builder—May 28, 1898. No. 20703 A.

Foundations of the Franklin Building. Illustrated description of unusual concrete and steel grillages. 500 w. Eng Rec—May 28, 1898. No. 20543.

Substructures of Tall Buildings.—A Review of Recent Developments and Typical Features. Frank W. Skinner. Emphasizes the need of thorough exploration of the soil below the site, and briefly describes methods used in recent high buildings. Ill. 4500 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21130 D.

Hospital.

The Bettina Pavilion in the Elizabeth Hospital at Vienna. (Der Bettina-Stiftungs Pavillon im k. k. Elisabeth-Spital in Wien.) Plans, elevations and description of the handsome hospital pavilion founded by Baron Rothschild in memory of his deceased wife. 4500 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—June, 1898. No. 21057 D.

House Planning.

Suggestions on House Planning. Grant Hollwell. Read before the Toronto Chapter of Architects. Gives analysis of a plan in its general aspect, and in the details of separate rooms, with examples and remarks. 3000 w. Can Arch—June, 1898. No. 20984 C.

Libraries.

The Libraries of the Middle Ages. T. G. Jackson. Describes the libraries of the middle ages, comparing them with those of the present day. Illustrations and discussion. 13600 w. Jour Roy Inst of Brit Archts—May 21, 1898. No. 20952 B.

Masonry.

Pueblo Masonry. Cosmos Mindeleff, in the Sixteenth Annual Report of the Bureau of American Ethnology. Describes the methods of construction. 1100 w. Stone—June, 1898. No. 21215 C.

Museum.

The New Galleries of the Museum of Natural History, at Paris. (Les Nouvelles Galeries du Muséum d'Histoire Naturelle, à Paris.) With exterior and interior views, also plans and elevation of the fine buildings for the Paris Zoological Museum. 2500 w. 1 plate. Le Génie Civil—May 21, 1898. No. 21001 D.

Reconstruction.

Removing the Pier of a 250-Ton Column. Illustrates a method of replacing masonry by steel to gain cellar space. 700 w. Eng Rec—May 28, 1898. No. 20554.

Steel Framing.

The Steel Frame of the St. Louis Coliseum. E. W. Stern. The remarks are confined to the ironwork of the structure. Gives a general description, with details of construction, illustrations and diagrams. 3000 w. Jour Assn of Engng Soc's—May, 1898. No. 20981 C.

Underpinning.

Developments of Architectural Construction. Illustrated description of methods of underpin-

ning heavy party walls. 2700 w. Eng Rec—June 4, 1898. Serial. 1st part. No. 20650.

HEATING AND VENTILATION.

Carbonic Acid.

Causes of Uncertainty in the Testing for Carbonic Acid in Large Volumes of Air. (Sur Quelques Causes d'Incertitude dans le Dosage de l'Acide Carbonique dans de Grands Volumes d'Air.) A paper by M. Armand Gautier giving details of methods and results. 3500 w. Comptes Rendus—May 16, 1898. No. 21028 D.

Carbonic Oxid.

Method of Testing the Presence of Carbonic Oxid in Air. (Méthode pour Reconnaître et Doser l'Oxyde de Carbone en Présence des Traces de Gaz Carburés de l'Air.) A paper presented before the French Academy by M. Armand Gautier, showing delicate methods of testing impurities in the atmosphere. 3000 w. Comptes Rendus—May 9, 1898. No. 21025 D.

Car Ventilation.

See Railway Affairs, Equipment.

Church.

A Church Heating and Ventilating System. Illustrates and describes the system adopted for the Presbyterian church at Sixty-second street and Woodland avenue, Chicago, Ill. A special feature is the free circulation of warmed air by means of specially constructed and arranged ventilators, with the aid of small gas heaters placed at the bottom of the ventilating shafts. 1800 w. Met Work—June 25, 1898. No. 21156.

Heating and Ventilation in the George W. South Memorial Memorial Church of the Advocate, Philadelphia. Pa. Brief description of one of the most magnificent churches in the United States, with detail drawings of heating and ventilating plant. The installation is a system of indirect radiation, supplemented by a blower with tempering coils. 1500 w. Heat & Ven—June 15, 1898. No. 20949.

Combination System.

Combined Hot Water and Low Pressure Steam Heating System. (Kombinierte Warmwasser und Niederdruckdampf-Heizung.) F. Eclbo. Radiators in the basement are supplied with hot water from below the water line, those in upper floors by steam. 1200 w. Gesundheits-Ingenieur—May 31, 1898. No. 21069 B.

Drying.

Drying Installations. (Trockenanlagen.) M. Grellert. A general investigation of the various methods of drying, with computations of the quantities of heat required to accomplish given results. 2500 w. Gesundheits-Ingenieur—May 15, 1898. No. 21066 B.

Electric Heating.

Heating by Electricity. (Le Chauffage par l'Electricité.) A theoretical investigation of the thermal and electrical conditions involved in heating by electricity, and a comparison with usual sources of heat, as regards cost. 2000 w. La Revue Technique—June 10, 1898. No. 21024 D.

Formulas.

German Formulas and Tables for Heating and Ventilating Work. J. H. Kinealy. The first of a series of articles containing information translated from the German, principally relating to the determination of the radiation surface required by different systems of heating to supply the heat lost through walls of different kinds. 1100 w. Met Work—June 18, 1898. No. 20868.

Grates.

English Fire Grates. Frederick Dye. Information upon the English methods of construction. Ill. 1500 w. Heat & Ven—June 15, 1898. Serial. 1st part. No. 20950.

Heating Plant.

The Heating Plant of the Verity Plow Company, Brantford, Ont. Description and drawings of the heating and power plant being installed in the new works of this company. 1700 w. Ir Age—June 16, 1898. No. 20856.

Hot-Water.

High-Pressure Hot-Water Heating. Frederick R. Farrow. Review of a paper describing characteristic British practice. 800 w. Eng Rec—June 18, 1898. No 20941.

Post-Office.

Ventilation of the Omaha Post-Office. Illustrated description of the design and construction of an elaborate job. 1700 w. Eng Rec—June 4, 1898. No. 20652.

Prison.

Engineering Features of the Philadelphia City Prison. Illustrated description of the plumbing, ventilation and heating of a prison for 600 inmates. 2000 w. Eng Rec—June 18, 1898. No. 20940.

Public Buildings.

The Warming of Public Buildings. Frederic R. Farrow. A lecture delivered before the Sheffield Society of Architects and Surveyors. Considers hot air heating, hot water, low and high pressures, steam, &c. 8000 w. Jour of Roy Inst of Brit Archts—May 7, 1898. No. 20754 B.

Steam Plant.

Distributing Steam for a Michigan Hospital. Part first describes the large steam plant and heating conduits in the Newberry hospital, where there are 11 detached buildings to receive steam and hot water. Ill. 2200 w. Eng Rec—June 25, 1898. Serial. 1st part. No. 21166.

PLUMBING AND GASFITTING.

Australia.

Plumbing in Australia. Dewdney Ellis. A general description of the conditions of the plumbing trade, with illustrations of devices in common use. 2000 w. Dom Engng—June, 1898. No. 20982 C.

Baths.

The Yonkers, N. Y., Public Bath. Illustrated description of a bath with 22 showers, 2 tubs and two toilet rooms. 700 w. Eng Rec—May 28, 1898. No. 20545.

Club House.

Plumbing in the University Club, New York City. Illustrated description of elaborate work in an 8-story 160 x140 ft. club house. Part first deals with the general water-supply system. 1600 w. Eng Rec—June 11, 1898. Serial. 1st part. No. 20807.

Country Houses.

Sanitation of Country Houses, Villages, and Small Areas. Edward Tidman. Considers the general principles to be adopted, describing the essential points of the drainage, outfall, &c. 2500 w. San Rec—June 10, 1898. No. 20924 A.

Piping.

Notes on the Discharge Piping of Houses. (Vortrag über Hausentwässerungsleitungen.) An address by building inspector Olshausen of Hamburg, upon the best arrangement of discharge pipes for the connection of various portions of buildings with the sewer. 3500 w. Gesundheits-Ingenieur—May 15, 1898. No. 21067 B.

MISCELLANY.

Architectural Manuscripts.

Art and Architecture in the Castle Howard Manuscripts. Extracts relating to men famous in art and architecture are given. 3000 w. Builder—June 4, 1898. No. 20821 A.

Australia.

Architectural Progress in Australia. Information from advance proof of an article in the "Year Book of Australia," concerning the building progress in these colonies. 3300 w. Arch, Lond—May 20, 1898. No. 20573 A.

Building Stones.

Quarrying and Finishing Building Stones. W. H. Nichols. Describes the equipment and method of operation in quarrying and working. Ill. 1900 w. Eng & Min Jour—June 11, 1898. No. 20778.

Columns.

See Civil Engineering, Miscellany.

Competition.

Regulating Competition—Methods of Estimating. F. E. Kidder. Calls attention to the evils arising from the bidding below a living profit, and discusses some methods of prevention. 1000 w. Br Build—June, 1898. Serial. 1st part. No. 21225 C.

Gardens.

The Château Gardens of André Le Nôtre. Elizabeth W. Champney. An explanation of the work of this great landscape-gardener, with illustrations and description. 2200 w. Arch Rev, Vol. II, No. IV. Serial. 1st part. 20882 F.

Moving Buildings.

Moving a Railroad Building at Frodsham, England. Describes the moving of a brick structure at a cost of five cents per cu. ft. 1200 w. Eng Rec—June 11, 1898. No. 20804.

Ornamental Iron.

Architectural Wrought Iron Ornament. W. Martin Aiken. A very highly illustrated article describing the growth of ornamental wrought iron work in architectural decoration. 3500 w. Engineering Magazine—July, 1898. No. 21239 B.

Terra-Cotta.

Note on Terra Cotta for Exterior Polychrome Decoration. Elmer Ellsworth Garnsey. Urging the study of color for exterior and interior decoration, and the possibilities of terra-cotta as a material in the façades of large buildings. 3500 w. Br Build—June, 1898. No. 21223 C.

Timber Tests.

See Civil Engineering, Miscellany.

Valuing.

Bases of Value. W. B. Woodhead. A paper read before the Bradford Society of Architects and Surveyors, England. Aims to point out the main principles which should underlie all valuations. 4200 w. Arch't, Lond—June 10, 1898. No. 20969 A.

William Morris.

The Life-Work of William Morris. F. S. Ellis. A review of his artistic and literary career, with recognition of his noble character. Discussion. 10800 w. Jour Soc of Arts—May 27, 1898. No. 20701 A.

CIVIL ENGINEERING.

BRIDGES.

Arches.

Repairs of Masonry Arch. A. E. Harvey. Describes repairs to stone arches which are quite a departure from the usual practice. Ill. 1500 w. Technograph, No. 12—1897-8. No. 20915 D.

Three-Hinged Masonry Arches, Long Spans Especially Considered. David A. Molitor. The aim of the paper is to demonstrate that masonry arches may be constructed on any good foundation, such as hard clay, and that they will admit of an accuracy and simplicity of design quite equal to that attainable with iron and steel. Ill. 12000 w. Pro Am Soc of Civ Engs—June, 1898. No. 21176 F.

Erection.

Bridge Erection. Frank H. Constant. Discusses some of the most common methods. 3800 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20662 E.

Foundations.

The New York Anchorage of the New East River Bridge. Illustrated description of an unusual plant for concrete work. 2700 w. Eng Rec—June 18, 1898. No. 20934.

Girders.

The Iron Girder Bridges of the Vienna City Railway (Die Eiserne Balkenbrücken der Wiener Stadtbahn.) Sigmund Kulka. With details and photographic view of these fine girders of

spans from 50 to 80 feet. 3500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—May 20, 1898. No. 21051 B.

Loading.

Typical Loading for Railway Bridge Specifications. Extract from paper by W. H. Schuerman, read at meeting of the Engng. Assn. of the South. Treats of loading which gives stresses which need only to be multiplied by a factor to give stresses agreeing closely enough for all practical purposes with the stresses produced by any of the specified loadings in general use. 2000 w. Ry & Engng Rev—June 18, 1898. No. 20929.

Park Bridge.

Erection of a Fairmount Park Bridge. This bridge has three 200-feet arch spans, erected by falsework and traveler of unusual form. Ill. 800 w. Eng Rec—June 4, 1898. No. 20645.

Pittsburg Bridge.

The Panther Hollow Bridge, Pittsburg, Pa. An illustrated description of the design, construction, and erection of a 3-hinged arch of 360-ft. span. 1300 w. Eng Rec—June 4, 1898. No. 20644.

Rock Island Bridge.

Erection of the Rock Island Bridge. Illustrated description of method used for an 1830 ft. bridge over the Mississippi, where an old bridge had to be replaced without interrupting trains. 1800 w. Eng Rec—May 28, 1898. No. 20536.

Skew Bridges.

A Graphic Method of Setting Out the Face-Angles of Skew Bridge Voussoirs. H. H. Humphreys. Gives an explanation of the method devised by Mr. D. Connery for solving the problem. Ill. 1000 w. Builder—June 18, 1898. No. 21201 A.

CANALS, RIVERS AND HARBORS.

Concrete.

Concrete Masonry, Illinois & Mississippi Canal. Gives the rules for building large concrete locks by day labor. 2500 w. Eng Rec—May 28, 1898. No. 20537.

Dam.

The Canyon Ferry Dam Theron M. Ripley. Description of this work, with map, illustration, and discussion. 2500 w. Jour Assn of Engng Soc's—May, 1898. No. 20979 C.

The Failure of the Lynx Creek Masonry Dam, near Prescott, Arizona. Jas. D. Schuyler. Notes on this disaster with photographs taken on a recent visit. 1200 w. Eng News—June 9, 1898. No. 20769.

The Movable Dam on the Big Sandy, River. (Barrage Mobile du Big Sandy.) A French account of this important needle-dam on the Big Sandy River, Kentucky. 3000 w. 1 plate. Le Génie Civil—May 14, 1898. No. 21000 D.

Dredging.

Dredges and Dredging on the Mississippi River. J. A. Ockerson. Presents a general view of the physical conditions, showing the problem requires different treatment in different parts of the river, and its general complexity; describes some devices for the removal of sand bars and other work, and their operation; gives illustrated description of numerous dredges and auxiliary machinery, and shows the magnitude of the work undertaken. Ill. 28300 w. Pro Am Soc of Civ Engs—June, 1898. No. 21174 F.

Graving Dock.

The New-Graving Dock of the Clyde Navigation Trust. Illustrated description of the Glasgow Dock—No. 3, and its construction. 4000 w. Engr, Lond—May 20, 1898. Serial. 1st part. No. 20578 A.

Great Lakes.

Reservoir System of the Great Lakes of the St. Lawrence Basin. Hiram M. Chittenden. Its relation to the problem of improving the navigation of these bodies of water and of their connecting channels. With a mathematical analysis of the influence of reservoirs on stream flow, by James A. Seddon. Diagrams. 17500 w. Pro Am Soc of Civ Engs—June, 1898. No. 21175 F.

Harbor Improvement.

Improving the Harbor of Duluth. The reconstruction of the entrance piers for this harbor, and other improvements on the Great Lakes are discussed. 1000 w. Ir Age—June 9, 1898. No. 20780.

Lighthouse.

The Prongs Lighthouse. J. H. E. Hart. An illustrated account of a lighthouse built at the entrance of the Bombay harbor. 4800 w. Engr, Lond—June 3, 1898. No. 20824 A.

Lock.

Lock Reconstruction on the Oswego Canal. Illustrated description of large concrete locks, with limestone facing. 1100 w. Eng Rec—June 25, 1898. No. 21160.

The Lock of the Dortmund-Ems Canal at Henrichenburg. From the *Illustrirte Zeitung*. Illustrated description of a lock that overcomes a difference in level of fifty-nine feet. 500 w. Sci Am Sup—June 25, 1898. No. 20996.

Madras.

Madras Harbor. W. B. de Winton. A review of F. J. Wilson's boat basin project, stating objections to the proposals and offering his own views on the subject. 2000 w. Ind Engng—May 14, 1898. No. 20819 D.

Mississippi.

The Chronology of the Mississippi System. James L. Greenleaf. Discusses the conditions that influence the chronology of flow, especially the variation in intensity of rainfall and temperature. Map. 2200 w. Sch of Mines Quar—April, 1898. No. 20668 D.

Nicaragua.

See Economics and Industry, Commerce and Trade.

IRRIGATION.

Arid Regions.

Experiences in the "Arid Southwest." Solon M. Allis. Describes the physical features of this region, and the difficulties in obtaining the needed water supply, giving personal experiences.

3500 w. Jour of New Eng Water-Works Assn —June, 1898. No. 20907 F.

Turlock District.

A Great Irrigation Enterprise. Some information relating to the Turlock irrigation enterprise in San Joaquin, Cal., valley. Ill. 700 w. Min & Sci Pr—June 18, 1898. No. 21155.

MISCELLANY.

Address.

Address before the Montana Society of Engineers. C. W. Goodale. Reviews some important engineering works in the state that have been executed during 1897. Ill. 5800 w. Jour Assn of Engng Soc's—May, 1898. No. 20978 C.

Beams.

The Efficiency of Built-Up Wooden Beams. Edgar Kidwell. Discussion of this paper which was presented at the Lake Superior meeting, July, 1897. 6300 w. Trans of Am Inst of Min Engs—June, 1898. No. 21136 D.

Cement.

Hydraulic Cements. Clifford Richardson. Discusses the characteristics of the best Portland cement, and its setting, hardening, &c. Also natural cements. 1800 w. Br Build—June, 1898. Serial. 1st part. No. 21224 C.

The Effect of Freezing Cement Mortar. A. C. Hobart. Describes experiments made, giving results which differ from generally accepted ideas. 3000 w. Technograph, No. 12—1897-8. No. 20911 D.

Cement Construction.

See Architecture and Building, Construction.

Cement Testing.

Cement Testing, Metropolitan Water-Works. Reprinted from the Third Annual Report of the Metropolitan Water Board. Describes the methods adopted by F. P. Stearns on the water-works for Boston and vicinity. 1200 w. Eng Rec—May 28, 1898. No. 20538.

Standard Methods of Testing Cement. Rules deduced by Max Gary to prevent variations by changes in manipulation. 700 w. Eng Rec—May 28, 1898. No. 20534.

Testing with the Böhme Hammer Apparatus. (Prüfung der Hammerapparate, Bauart Böhme.) The cement is placed in a mould and struck rapidly by a mechanically operated triphammer, which also records automatically the number and amplitude of its blows. 1800 w. Mitt Aus d Kgl Tech Versuchsanstalt—Part 2, 1898. No. 21071 G.

Columns.

Tests of Full-Sized Cast-Iron Columns. Wm. H. Burr. Table giving results of tests made, also a graphical representation of results, with explanatory notes and comments. 1600 w. Sch of Mines Quar—April, 1898. No. 20667 D.

The Present Status of the Cast-Iron Column. A review of the changes in old methods of computation caused by recent full-size tests. 1100 w. Eng Rec—June 11, 1898. No. 20801.

Concrete.

Placing Concrete in Ninety Feet of Water. Daniel W. Mead. Describes unusual work at Rockford, Ill. 800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21127 D.

Properties of Concrete Under Compressive Stress. David Molitor. Gives the best available data on this subject, though the number of experiments is rather limited. Ill 2500 w. Jour Assn of Engng Soc's—May, 1898. No. 20980 C.

Strength of Concrete of Various Proportions. R. B. Ketchum and Fred. W. Honens. A summary of results of a series of experiments made in the Cement Laboratory of the Univ. of Illinois, to determine the variation in strength of concrete due to a difference in the proportion of the ingredients. 600 w. Technograph, No. 12—1897-8. No. 20913 D.

Drainage.

Reclamation of Wet Land in the Red River Valley. W. R. Hoag. An account of the drainage of valuable wheat land in Minnesota, the difficulties met and overcome. 2500 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20660 E.

Expert Testimony.

The Use of Scientific Books by Expert Witnesses. A decision of the U. S. Circuit Court upon the subject of excluding scientific books from the witness stand. 600 w. Eng Rec—June 11, 1898. No. 20800.

Laboratory.

The Great Hydraulic Laboratory at Cornell. Harley S. Gibbs. The important features of its construction, its purposes, and aims. Ill. 2300 w. Trans of Assn of Civ. Engs of Cornell Univ—1898. No. 21131 D.

Piers.

Brick Piers. Results of Tests made in the Laboratory of Cornell University, 1897-8. Ill. 800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21134 D.

Retaining Walls.

A Rational Theory of Retaining Walls. (Rational-Theorie der Stutzmauern.) R. Iszkowski. A general discussion of the subject of earth pressure in retaining wall design, with tables, formulas and a sheet of diagrams. 3500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—June, 1898. No. 21059 D.

Roads.

The Road Construction System in the Tyrol. (Der Ausbau des Concurrenzstrassennetzes in Tirol.) With map showing the extent to which the official plans have thus far been executed. 2000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—June, 1898. No. 21058 D.

The Roman Highways. D. R. McAnally. Describes these remarkable roads and their construction. 1500 w. Ap Pop Sci M—June, 1898. No. 20638 D.

Surveying.

Description of a Topographical Survey of a Four-Thousand-Acre Tract. Edwin Duryea. A detailed description of a survey in Indiana that needed very accurate maps in order to dispose and arrange many industries. 12800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21132 D.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

China.

American Competition in China. Editorial on the influence of war on trade and industry, and special consideration of the expansion of United States trade in China. 1500 w. Engng—June 3, 1898. No. 20832 A.

Foreign Commerce in China in 1897. Reports the foreign trade for 1896 the largest ever record d. The year of 1897 is the third best on record. 800 w. Cons Repts, No. 132—June 4, 1898. No. 20635 D.

The Commercial Importance of the Yang tze. Information concerning the economic condition of the several ports open for trade on this river, taken from the report of F. S. A. Bourne, British consul. 3800 w. Bd of Trd Jour—June, 1898. No. 21208 A.

The First Steamer at Chungking. Some interesting notes on trade in the Yang Tsi Kiang region, with report of the first British steamer that has made its way to this important distributing center. 700 w. Engng—May 27, 1898. No. 20713 A.

Colonies.

Colonies and Chartered Companies. Alfred C. Lyall. An interesting address containing matters of interest relating to trade. Discussion. 10800 w. Jour Soc of Arts—June 3, 1898. No. 20813 A.

United States Trade in North China. Extract from the annual report for 1897, by Mr. Taylor, statistical secretary of customs, Shanghai, with remarks by the U. S. consul, showing that the U. S. interests in this part of China are second to none. 2500 w. Cons Repts. No. 145—June 20, 1898. No. 20951 D.

Consular Services.

On the Utilization of Consular Services in the Interests of British Trade and Commerce. Edward H. Carbutt. Refers to the work of the American Bureau, and offers suggestions with a view to improving the Consular Reports for purposes of British commerce. 3700 w. Ir & Coal Trds Rev—May 20, 1898. No. 20567 A.

Exports.

Exports of Locomotives and Some Other Material. Editorial on the growth of our foreign trade in locomotives, giving interesting statistics, and information. 1300 w. R R Gaz—June 17, 1898. No. 20895.

Foreign Trade.

The Cash System in the Foreign Trade. Emil Maritschek. A discussion of the present system of payment in the American export and import trade, with suggestion for needed improvement. 700 w. Ir Age—June 9, 1898. No. 20779.

France.

British Trade with France. Report of the British consul shows a continuous diminution of demand for British goods. 1800 w. Bd of Trd Jour—June, 1898. No. 21211 A.

Germany.

Germany's Trade with South America. Some information relating to the articles of export, with tables showing the changes that have taken place, and the efforts to be made to conquer the South American market for Germany. 700 w. Cons Repts, No. 126—May 27, 1898. No. 20527 D.

Some Factors in the Industrial Progress of Germany. Editorial on the report of T. R. Mulvany, the British consul at Dusseldorf, on trade in Germany. 2500 w. Engng—May 27, 1898. No. 20711 A.

Great Lakes.

The Carrying Trade of the Great Lakes. Allan Hendricks. Considers the great importance of the commerce of these lakes, the modern type of freight carriers, the projects for enabling the lake steamers to reach the ocean, passenger boats and other craft, and related matters of interest. 4400 w. N Am Rev—June, 1898. No. 20655 D.

Hire-Purchase.

Hire-Purchase Wagon Accounts and Agreements. George Johnson. An explanation of the practice of colliery and manufacturing companies by which they pay for the wagons by equal periodical instalments, with interest. 1600 w. Col Guard—June 10, 1898. Serial. 1st part. No. 20962 A.

Iron Trade.

Shipping Freights and Conferences as Affecting the Iron and Steel Trades. J. Stephen Jeans. Read before the British Iron Trade Assn. A statement of the conditions which seem to be greatly affecting the position and prospects of British trade. 4500 w. Ir & Coal Trds Rev—June 3, 1898. No. 20841 A.

Japan.

The Foreign Trade of Japan for 1897. Calls attention to some of the most important points in the British annual report on foreign trade of Japan. 2200 w. Engng—June 17, 1898. No. 21183 A.

Nicaragua.

National Influence and the Isthmian Canal. Lewis M. Haupt. A discussion of the military and commercial importance to the United States of a canal through the isthmus, and the desirability of having it under the control of the U. S. government. 3500 w. Engineering Magazine—July, 1898. No. 21231 B.

Prices.

Comparative Prices of 107 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Tabulated statement with comments on prices for May, 1898. 4000 w. Bradstreet's—June 11, 1898. No. 20782.

Siberia.

The Opening of Siberia. Information concerning this extensive and richly endowed region, its mineral riches, industries, and the opening for foreign trade. 2800 w. Bd of Trd Jour—June, 1898. No. 21209 A.

South America.

How to Extend United States Trade in South America. Urging young men to go to this region and learn the language, methods of business, etc. 900 w. Cons Repts, No. 126—May 27, 1898. No. 20528 D.

Syndicates.

The Syndicates in Germany. An account of these combines to better industrial conditions, and the way the business is conducted. 2500 w. Ir Age—June 2, 1898. No. 20619.

Tariff.

Revised Tariff of Values for British India. Schedule of previous and present valuations for the purposes of comparison. 1200 w. Bd of Trd Jour—June, 1898. No. 21212 A.

Tariff Changes and Customs Regulations. Russia, Norway, Sweden, Germany, Belgium, France, Portugal, Spain, Bulgaria, United States, Peru, Ecuador, Persia, Gibraltar, British India, and Victoria. 5500 w. Bd of Trd Jour—June, 1898. No. 21213 A.

Tin Plate.

Decline of British Export Trade: Tin-Plate Industry. Gives two commercial editorials from the Birmingham *Daily Post* dealing with downward tendency of British export trade. Also a paper by John Jenkins read at meeting of British Iron Trade Assn. 8000 w. Cons Repts, No. 140—June 14, 1898. No. 20847 D.

Trade-Marks.

Trade-Marks in Cape Colony. Copy of the trade-marks act, and of rules and regulations relating to registration. 4200 w. Cons Repts, No. 136—June 9, 1898. No. 20734 D.

Trade Methods.

British versus German Trade Methods in Spain. Some of the reasons why German goods are preferred. The importance of securing British travelers acquainted with the Spanish language to look after the interests of trade in Spain. 1500 w. Bd of Trd Jour—June, 1898. No. 21210 A.

Trade Statistics.

Some Contrasts in British and American Trade. Comment on the foreign trade of the respective countries, British trade falling off while American trade is increasing. Some explanation of the trade returns, and how far they are misleading. 900 w. Bradstreet's—June 25, 1898. No. 21167.

CURRENCY AND FINANCE.

Bimetallism.

Bimetallism and the Silver Producing Industry in the United States. (Le Bimetallisme et l'Industrie de l'Argent aux Etats-Unis.) E. Detienne. An interesting view of the relations between the production of silver and the bimetallic theories, as viewed by a Belgian engineer. 7500 w. 1 plate. Revue Universelle des Mines—May, 1898. No. 21097 H.

Circulation.

The Precious Metals. Jerome Dowd. On the influences which govern their flow from one country to another. 1100 w. Banker's Mag, N. Y.—June, 1898. No. 20902 D.

Currency Reform.

The Currency Reform Bill. Synopsis of the bill for currency reform reported by the House Committee on Banking, May, 1898. 1700 w. Banker's Mag, N. Y.—June, 1898. No. 20903 D.

Gladstone.

Mr. Gladstone as a Financier. Extracts from article in the *Financial Times*, from the standpoint of his achievements when in the position of Chancellor of the Exchequer. 2500 w. Banker's Mag, Lond—June, 1898. No. 20671 B.

LABOR.

Accidents.

The Law Upon Accidents to Workingmen. (Loi sur les Accidents du Travail.) The full text of the new French law fixing the responsibility for accidents occurring to workingmen during the course of labor. Indemnities for death or disability are based upon the earning capacity of the individual. 3000 w. La Revue Technique—May 25, 1898. No. 21019 D.

American Workmen.

A French View of the American Working-Man. Theodore Stanton. Remarks on the history of "L'Ouvrier Américain" by Emile Levasseur, the most complete work ever written by a foreigner on the subject of the American working-man. 3000 w. Forum—June, 1898. No. 20657 D.

Compensation Act.

The Insurance Companies and Employers. Editorial on the exorbitant premiums demanded, quoting from speech of Joseph Chamberlain before the Birmingham (Eng.) Liberal Unionist Assn. 1800 w. Engr, Lond—June 17, 1898. No. 21188 A.

The Oppressed "Undertakers." Editorial on the Workmen's Compensation Act of 1897, in England, showing the additional burdens placed on employers. 2200 w. Engr, Lond—June 3, 1898. No. 20825 A.

The Workmen's Compensation Act. A communication from Showell Rogers, of Birmingham, to the London *Times*. Discusses the scheme of the act and its defects. 2200 w. Arch't, Lond—June 10, 1898. No. 20970 A.

The Workmen's Compensation Act. An analysis of this act about to come in force in England, by a member of the Junior Bar. 2800 w. Engr, Lond—June 10, 1898. No. 20967 A.

The Workmen's Compensation Act. R. T. Thomson. Deals with the principal features of this important measure in England, pointing out some of the anomalies, and considering the financial aspect from the employers' point of view. 7000 w. Nineteenth Cent—June, 1898. No. 20896 D.

Co-operation.

Co-operative Production. Editorial on Lord Brassey's article in the *Nineteenth Century* for June, and discussing the chief obstacles to the successful development of a co-operative system. 2000 w. Engng—June 10, 1898. No. 20957 A.

The Difficulties and the Limits of Co-operation. Lord Brassey. A review of the progress thus far made in co-operative and profit-sharing

industries. Deals with the attempts of workmen to become their own employers, giving examples and showing that in practice difficulties have in many instances led to failures; that profit-sharing has not been successful, and discusses what could be accomplished by Trades Unions. 8500 w. Nineteenth Cent—June, 1898. No. 20897 D.

Eight-Hour Day.

The Eight-Hour Day on Government Work. Arguments of representatives of the leading iron and steel manufacturerers before the U. S. Senate Committee on Education and Labor, protesting against the passage of the pending bill which has already been favorably acted upon by the House. 2800 w. Ir Age—June 23, 1898. No. 20998.

Insurance.

Working-Men's Insurance. Reviews a work recently published by William Franklin Willoughby, showing the importance of this subject and the way it is regarded in different countries. 1600 w. Builder—May 21, 1898. No. 20574 A.

Japan.

Factory Labor in Japan. Discusses the proposed legislation for factory regulation, giving extracts of interest in connection with the subject. Ill. 2800 w. Ind & East Engr—May, 1898. Serial. 1st part. No. 20845 D.

Labor Conditions.

Textile War between the North and the South. Jerome Dowd. A comparison of wages, cost of living, &c., of the wage-earners in the north and south, with special reference to the textile industries. 2800 w. Forum—June, 1898. No. 20656 D.

Labor Question.

New Lights on the Labor Question. Reviews two articles which have recently appeared in the "Quarterly" and "Edinburgh Reviews," bearing on this subject. 2200 w. Jour Gas Lgt—May 24, 1898. No. 20598 A.

Liability.

Employers and Workmen's Liability Laws. Pasquale Villari. Translated from *Nuova Antologia*. A study of the law and its effects in the countries most obedient to it. 2200 w. Chau—June, 1898. No. 20549 C.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Bullion.

Electrolytic Methods of Bullion Refining John B. C. Kershaw. An account of Dr. Wohlwill's method for refining gold bullion, giving details of the process. The advantages claimed over the older methods, are those of greater economy and convenience. 2300 w. Elect'n, Lond—June 3, 1898. No. 20843 A.

Electrolytic Assay.

See Mining and Metallurgy, Copper.

Electro-Metallurgy.

Progress in Electro-Metallurgy in 1897. E. Andreoli. Reviews the processes in use and the new methods applied to various branches of the industry. 3400 w. Eng & Min Jour—June 18, 1898. No. 20947.

Recent Applications of Electro-Chemistry to the Metal Industries. Sherard Cowper-Coles. Describing the modern electro-galvanizing methods, also devices for removing mill scale, for the production of parabolic reflectors, and other recent applications of electro chemical methods. 3000 w. Engineering Magazine—July, 1898. No. 21235 B.

The Application of Electricity to Metallurgy on the Large Scale. (Die Rolle der Elektricität bei der Jetzigen Metallgewinnung in Grossen.) Dr. Dürre. A general review of the present state of the art of electrometallurgy, with especial reference to the winning of metals from their ores. 7500 w. Elektrotech Zeitschr—June 2, 1898. No. 21085 B.

Furnace.

Description of Experimental Electric Furnace. (Mitteilung über einen Versuchsofen.) Dr. Borchers. An illustrated description of a convenient form of electric furnace for use in general laboratory research. 1200 w. Zeitschr f Elektrochemie—May 20, 1898. No. 21088 H.

Mercury.

The Constitution of Mercury. (Ueber die Konstitution des Quecksilbers.) C. Liebenow. A paper before the Electrochemical Society showing mercury to be composed of molecules of different atomic constitution. 3500 w. Zeitschr f Elektrochemie—May 20, 1898. No. 21087 H.

Ozone.

I. Electrical Production of Ozone. II. Purification and Sterilization of Water by Ozone. The first article is an illustrated description of apparatus devised by Mr. Andreoli, for producing ozone. The second describes the treatment of the water of the river Seine. 2500 w. W Elect'n—May 28, 1898. No. 20552.

Review.

The Industrial Applications of Electro-Chemistry. Thomas Ewan. Briefly reviews the progress in this field since 1792, giving a general description of processes actually employed. 5500 w. Nature—June 2, 1898. No. 20814 A.

Separation.

A Method for the Separation of Cobalt and Nickel. (Eine Methode zur Trennung von Kobalt und Nickel.) Dr. Coehn. A description of the electro-capillary method, using capillary glass electrodes. 1200 w. Zeitschr f Elektrochemie—May 20, 1898. No. 21086 H.

Voltameter.

The Hydrogen Voltameter and its Reliability. (Das Wasserstoff Voltameter und seine Zuverlässigkeit.) H. A. Naber. Reviewing the investigations of Faraday and later physicists, and illustrating and describing a decomposition voltameter for precise work. 1800 w. Elektrochem Zeitschr—June 1, 1898. No. 21089 D.

LIGHTING.

Address.

Presidential Address; Chicago National Electric Light Association Convention. Samuel Insull. Discusses standard vs. special machinery, selling price based on cost, public control and private operation, &c. 5000 w. Elec Eng, N. Y.—June 16, 1898. No. 20864.

Heat Compensator.

Improved Heat Compensator for Shunt Arc Lamps. (Verbesserter Wärmekompensator bei Nebenschluss-Bogenlampen.) The Körting and Mathiesen device consists of a compound zinc-iron expansion apparatus connected with the regulator so as to compensate for changes of temperature. 3000 w. Elektrotech Zeitschr—May 19, 1898. No. 21079 B.

Lamp.

New Electric Lamps, and Methods of Production. (Neue Elektrische Lampe und Verfahren zu deren Herstellung.) A description of the new incandescent electric lamp invented by Dr. Karl Auer von Welsbach. 1500 w. Glaser's Annalen—May 15, 1898. No. 21065 D.

Lamp Economy.

Economy of Electric Lamps. G. W. Baird. A discussion of the need of close inspection of the quality of incandescent lamps, reporting tests made. 1600 w. Jour Am Soc of Naval Engs—May, 1898. No. 20682 H.

Lamp Tests.

Important Considerations in Lamp Tests When Determining the Best Available Lamp for Central Station Use. S. E. Doane. Abstract of paper read before the Northwestern Electrical Assn. Thinks the most important consideration is that the true rated candles be properly determined. In the writer's judgment they are the maximum reached. 2700 w. Elec Wld—June 25, 1898. No. 21110.

Lighting Plant.

A Modern Arc Lighting Plant. Describes an interesting transformation being carried out in Brooklyn, by which a generating station dependent upon boilers and steam engines for motive power is being changed into one directly driven by high tension three-phase current. Ill. 2000 w. Am Elect'n—June, 1898. No. 20762.

Lightning.

The Effect of Lightning upon Overhead Power Circuits and the Cheapest Method of Distributing Power. Arthur H. Gibson. Gives statements relating to a power transmission plant installed in South Africa, in a district particularly infested by lightning, giving peculiar behavior of arresters. Advises polyphase machinery, with sunk windings or hole wound, where lightning is troublesome. 1500 w. Elec Rev, Lond—June 3, 1898. No. 20818 A.

Public Lighting.

Public Lighting in Relation to Public Ownership and Operation. Alex. Dow. Abstract of a paper read before the Nat. Elec. Lgt. Assn., at Chicago. Sets forth a proposed policy applicable immediately to public lighting. 4000 w. Elec Wld—June 18, 1898. No. 20853.

Resistances.

Calculation of Electric Resistance Frames. E. Kilburn Scott. Tabulated particulars of iron-wire resistances, with explanatory notes. 1500 w. Prac Eng—May 20, 1898. No. 20572 A.

Signalling.

New System of Electric Signs and Signals. Illustrates and describes a device enabling electric signals to be spelled out on a large frame in lights visible several miles. 1000 w. Sci Am—June 4, 1898. No. 20625.

Small Currents.

Registration of Small Currents Used for Electric Lighting or other purposes. Alfred H. Gibbings. Abstract of a paper read before the Inst. of Elec. Engs., England. Describes a motor which the writer claims will register accurately from $\frac{1}{10}$ ampere to its range limit, dealing with its principle of action and registration, construction and probable cost, tests, &c. Discussion. Ill. 4400 w. Elect'n, Lond—May 20, 1898. No. 20570 A.

Sockets.

Gauges for Incandescent Lamp Sockets. (Kaliberlehren für Gluhlampenfüsse.) R. Hundhausen. A discussion of the construction of gauges for the standard lamp socket screw threads recommended by the German Electrotechnical Society. 1800 w. Elektrotech Zeitschr—June 2, 1898. No. 21083 B.

Standard Socket Threads for Edison Lamps. (Normalien für Edison-Gewinde.) R. Hundhausen. A description of the standard screw thread system for incandescent lamp sockets, as recommended by the German Electrotechnical Society. 1800 w. Elektrotech Zeitschr—May 19, 1898. No. 21078 B.

Storage Battery.

A Storage Battery Central Station. F. B. Sage. Illustrated description of the electric light plant of Claremont, N. H., which shows the advantage of storage batteries being applied to small lighting installations. 2000 w. Am Elect'n—June, 1898. No. 20761.

Chicago Edison Company's Storage-Battery Plant. Illustrated description of this latest feature of the central station distribution system of this company. It is the largest battery plant that has ever been installed. 2200 w. W Elect'n—June 4, 1898. No. 20742.

Street Lighting.

The Proper Illumination of City Streets. Henry Hopkins. Considers the requirements for satisfactory street lighting, giving illustrations. 900 w. Elec Eng, N. Y.—June 30, 1898 No. 21221.

Switchboards.

Switchboard Apparatus. J. R. Blaikie. Read at annual meeting of the Municipal Electrical Assn., London. Considers the duties and characteristics of the details, the disposition of the component parts, and shows the necessity of standard work. Also editorial. 8500 w. Elec Rev, Lond—June 10, 1898. No. 20971 A.

220-Volt System.

The 220-Volt and Alternating Current Sys-

tems. George D. Shephardson. A comparison of the two systems, giving the arguments for and against the 220-volt system as advanced by its advocates and opponents. 3800 w. Am Elect'n—June, 1898. No. 20764.

The 220-Volt System of Electric Lighting for Small Municipalities. W. I. Gray. Presents the advantages of this system showing why it has been so well received and describes the construction work. 1600 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20664 E.

Wiring Chart.

A Convenient Wiring Chart. R. Laurie Ellis. Illustrates an easy method for performing the calculations graphically, for feeders and service wires. 400 w. Elec Wld—June 25, 1898. No. 21107.

POWER.

Alternating Currents.

Elements of Complex Quantities and Vectors with Reference to Their Use in Alternating-Current Work. Franz J. Dommerque. A study of sine law for electro-motive force and current, showing that the E. M. F. changes by sines, while the magnetic flux changes by cosines of the same angle. Ill. 1800 w. Elec Engng—June 1, 1898. No. 20630.

Alternators.

A High or Low Tension Alternator. H. F. M. Dahl. Illustrates and describes the 10 K. W., ten pole, single phase, Slattery alternator belonging to the electrical engineering department of the University of Minnesota, which was remodeled according to a plan proposed by George D. Shephardson. 1000 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20663 E.

Batteries.

Batteries v. Generators. The question of reliance in electricity supply, favoring the storage system. 1500 w. Elec Rev, Lond—June 3, 1898. No. 20817 A.

Central Stations.

The Development of the Central Station. Samuel Insull. A lecture delivered before the School of Electrical Engineering of Purdue University. Part first is largely a review of Mr. Edison's work. 2400 w. Elec Eng, N. Y.—May 26, 1898. Serial. 2 parts. No. 20531 B.

Chart.

Chart. A. B. Herrick. A carefully worked out chart showing the limits within which various systems of transmission can be profitably employed. Elec Eng, N. Y.—June 9, 1898. No. 20753.

Cost.

Analysis of the Cost of the Generation and Distribution of a Unit of Electricity. Calvin W. Rice. Read before the Nat. Elec. Lgt. Assn., at Chicago. A résumé of the most reliable data, showing what has been done and what is being done. Considers the cost of the plant, cost of operation, &c. With discussion. 9500 w. Elec, N. Y.—June 22, 1898. No. 20990.

Distribution.

European Methods of Underground Distribution. Francis Jehl. Shows that European countries improve their cables, making them self-protective, instead of building expensive conduits, as is customary in England and America. Illustrates and describes methods used. 5000 w. Am Elect'n—June, 1898. No. 20766.

General Distribution from Central Stations by Alternating Currents. Herbert A. Wagner. Paper read before the Nat. Elec. Lgt. Assn., at Chicago. Compares and contrasts the different methods of distribution, reviewing those in general use, and describing the most recent developments, stating the features in which the alternating current has been shown to be superior. Elec Eng, N. Y.—June 16, 1898. No. 20863.

General Distribution from Central Stations by Direct Currents. Louis A. Ferguson. Read before the Nat. Elec. Lgt. Assn. at Chicago. Explains the method of distribution employed in the system of the Chicago Edison Co., considering what method gives the best efficiency, the value of the storage battery, its adaptation to elevator work, and other matters of interest. 7000 w. Elec Eng, N. Y.—June 16, 1898. No. 20865.

Economy Test.

An Economy Test of a Central Station. W. E. Goldsborough. An account of a number of tests made at one of the large electric lighting stations of Baltimore, Md., to determine along what lines, if any, the method of operating the station could be modified to improve its efficiency. Ill. 15000 w. Trans Am Inst of Elec Engs—April, 1898. No. 20991 D.

Electric Driving.

Electrically-Driven Calico Printing and Finishing Machinery. Presents the advantages of electric power in this work and gives illustration of a plant established in one of the largest Lancashire print works, noting some of the difficulties met. 800 w. Engr, Lond—May 27, 1898. No. 20705 A.

Electric Plows.

Electric Motor Plows. (Der Elektrische Motorpflug.) Dr. Müllendorf. A very fully illustrated description of the Zimmerman system of electric plows showing a complete installation, and giving detailed tabular statements of costs of maintenance and operation. 5000 w. Elektrotech Zeitschr—June 2, 1898. No. 21082 B.

Elevators.

Electric Elevators, with Special Reference to Their Starting and Stopping. W. C. C. Hawtayne. Read before the British Northern Soc. of Engs. Part first describes the Otis passenger elevator, the precautions taken to secure safety. 2300 w. Elec, Lond—May 20, 1898. Serial. 1st part. No. 20569 A.

Gas Plant.

A Gas Engine Central Station. J. J. Flather. Describes and illustrates an interesting installation at Lafayette, Ind., involving the most modern practice in gas engine construction and operation, and showing the economy obtainable under favorable conditions. 2400 w. Am Elect'n—June, 1898. No. 20760.

Generating Stations.

Single v. Multiple Generating Stations. John

F. C. Snell. Read at meeting of Municipal Electrical Assn., London. The writer favors multiple stations and discusses their advantages. Also editorial. 2800 w. Elec Rev, Lond—June 10, 1898. No. 20972 A.

The Law of Electric Generating Stations. The text of the report agreed upon by the Select Committee of both Houses of Parliament. 2200 w. Elect'n, Lond—June 10, 1898. No. 20977 A.

Generators.

Direct Current Generators in Parallel. Frank W. Springer. Outlines methods of obtaining characteristic curves, and discusses points of importance where generators are paralleled. 3800 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20665 E.

Insulation.

Insulation and Conduction. Reginald A. Fessenden. Gives an account of the manner in which a current passes through materials, discussing also the purposes for which insulation is used, and of substances best suited. Discussion and communications. 17000 w. Trans of Am Inst of Elec Engs—March, 1898. No. 20629 D.

Insulation Resistance and Leakage Currents. Alexander Russell. A method of testing the wiring of a building in a two-wire installation and a three-wire installation, and a discussion of the importance of accurate testing. 3000 w. Elect'n, Lond—June 10, 1898. No. 20976 A.

Leakage.

A Discussion of the Conditions of Leakage in Electric Machines. (Ein Beitrag zur Beurtheilung der Streuung Elektrischer Maschinen.) A. Rothert. A mathematical discussion of magnetic leakage in generators and motors. 5000 w. Elektrotech Zeitschr—May 26, 1898. No. 21080 B.

Marine Plant.

Electrical Apparatus on Shipboard. (Ueber Elektrische Schiffseinrichtungen.) A general description of marine electrical apparatus, including engine-room indicators, hoisting machines, steering devices, &c. 4500 w. Elektrotech Zeitschr—May 12, 1898. No. 21077 B.

Electric Power Transmission on Shipboard. F. W. Roller. Shows that auxiliary steam engines have a minimum of good qualities, although superior to hydraulic or pneumatic systems, and claims that an electrically driven installation would overcome most of the difficulties. 1800 w. Am Elect'n—June, 1898. No. 20767.

Motor Design.

The Design of Electric Railway Motors for Rapid Acceleration. Charles A. Carus-Wilson. Read at meeting of Inst. of Elec. Engs., England. A mathematical study. 6200 w. Elec Eng, Lond—May 27, 1898. No. 20702 A.

Niagara.

Developing Power of Lower Niagara. Orrin E. Dunlap. Concerning the development of the rapids of the lower Niagara. Map. 1600 w. W Elect'n—June 18, 1898. No. 20930.

Power Plants.

A Great Power House at Niagara. An illustrated description of the recent developments of the water power of Niagara Falls. 1700 w. Sci Am—June 18, 1898. No. 20854.

Economical Manner of Working Steam in Electric Power Plants. William S. Aldrich. Considers the increased economies to be obtained in the manner of working steam in the engine cylinders. 2700 w. Am Elect'n—June, 1898. No. 20768.

Electric Station at Amparo, Brazil. (Station d'Electricité du Amparo, Brésil.) Illustrated account of the hydraulic-power electric-lighting station for the city of Amparo, with views of the power plant and diagram of the distribution. 1200 w. Le Génie Civil—May 28, 1898. No. 21007 D.

Electric Power at the Golden Gate Mill, Utah. Describes the installation for operating the largest cyanide mill in the world Ill. 1400 w. Eng & Min Jour—June 25, 1898. No. 21170.

Power Plant of the Columbia Water Power Company. Describes the installation of this company, which utilizes the water of the Broad River, and includes a development of 3000 h. p. which is to be increased to 10,000 h. p. 1500 w. Elec Wld—June 11, 1898. No. 20748.

Power Plant of the New York and Staten Island Electric Company. Illustrated description of the new station which generates all the electric current used for lighting on the whole island, and most of the electric power used for traction purposes. 2800 w. Elec Wld—June 11, 1898. No. 20747.

Steam Using Plant. J. A. Jeckell. Read at meeting of Munic. Elec. Assn., London. Discusses various types of engines and their efficiency, and other means of economy and efficiency. Discussion. 5300 w. Elec Eng, Lond—June 10, 1898. No. 20975 A.

The Central Heating, Lighting and Power Plant. L. P. Breckenridge. Describes and illustrates the new plant for the buildings of the Univ. of Illinois. 1200 w. Technograph, No. 12—1897-8. No. 20912 D.

The Missouri-Edison Electric Company of St. Louis and Its Development of the Alternating Current System for Light and Power Distribution. Herbert A. Wagner. An interesting historical account of this company with illustrated detailed description of the three stations. 11000 w. Elec Eng, N. Y.—June 9, 1898. No. 20752.

The Missouri Edison Plant in St. Louis. George J. Percival. An illustrated description of the general features of the three stations of this company. 2300 w. Elec Wld—June 11, 1898. No. 20750.

The Utilization of the Water Power of the Muotta, near Schwyz. (Die Ausnützung der Wasserkräfte der Muotta oberhalb Schwyz.) A Forti. With views of the weir, and plans of the tunnel and power house, and a topographical map. 1200 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—June 3, 1898. No. 21054 B.

Reconstruction.

The Metamorphosis of an Electric Power Station. Illustrated description of changes made in the Albany street station in Boston. 1000 w. Power—June, 1898. No. 20626.

Transmission.

The Yuba-Marysville Transmission. Illus-

trated detailed description. 8000 w. Jour of Elec—May, 1898. No. 20983.

Uniformity.

On the Necessity of Uniformity in Plant and Apparatus. C. H. Wordingham. Read before the Munic. Elec. Assn., London. On the importance of restriction of the number of types and sizes of the articles produced. Argues that the electrical industry has reached that point in its development that makes this economy desirable. Discussion. 5000 w. Elec Eng, Lond—June 17, 1898. No. 21190 A.

TELEGRAPHY AND TELEPHONY.

Cables.

Submarine Telegraphy. A description of the cable lines of the world. 2300 w. Elec Rev, N. Y.—June 8, 1898. No. 20751.

Vibrating Cable Relay. K. Gulstad. Describes a cable relay for automatic working, or a special arrangement of interest. Ill. 1400 w. Elec Rev, Lond—June 3, 1898. Serial. 1st part. No. 20815 A.

Combined Systems.

Operating Telephone and Electric-lighting Systems in Conjunction. H. P. Clausen. Some valuable suggestions on the construction, operation and management of telephone systems of this character. Ill. 2000 w. W Elect'n—June 4, 1898. No. 20743.

Field Telephones.

The Telephone in War. Arthur R. Pardington. Describes the long distance equipment at Camp Black, and its valuable services. 700 w. Elec Rev, N. Y.—June 15, 1898. No. 20848.

Manufacturing Plants.

Telephone Systems for Large Manufacturing Plant. H. P. Clausen. Illustrated description of a simple manually operated system, wherein all calls are transmitted by the caller. 1800 w. W Elect'n—May 28, 1898. No. 20553.

Semaphore.

Semaphore Telegraph. Reviews the history of this system, now nearly out of use. 1200 w. Engr, Lond—June 3, 1898. No. 20828 A.

Space Telegraphs.

The Mooted Wireless Telegraphs. D. H. Keeley. A discussion of the different systems, and the possibilities. 2000 w. Can Elec News—June, 1898. No. 20869.

MISCELLANY.

Battery.

A Novel Form of Thermo-Electric Battery. C. J. Reed. Describes experiments which give further proof of the high thermo-electric power of metals in contact with electrolytes, with explanation of the results. Discussion. Ill. 10500 w. Trans Am Inst of Elec Engs—April, 1898. No. 20992 D.

Cooking.

Electric Cooking Apparatus. (Elektrische Kochapparate.) A description of the Voigt & Häffner apparatus, which, according to tests by Dr. Kittler, showed an efficiency of over 80 per cent. 1500 w. Gesundheits-Ingenieur—May 31, 1898. No. 21068 B.

Electric Heating.

See Architecture and Building, Heating.

Geissler Tubes.

A Theory to Explain the Stratification of the Electric Discharge in Geissler Tubes. H. V. Gill. Presents certain ideas regarding the cause of this phenomenon, and describes some experiments made to test the value of these ideas. Ill. 8000 w. Am Jour of Sci—June, 1898. No. 20658 D.

Hertz Waves.

The Hertz Electric Waves, and the Consequent reform in Physics. (Ueber die Hertzschen Elektrischen Schwingungen und die damit Zusammenhängende Reform der Physik.) Dr. Holzmüller. An elementary investigation of the Hertz waves, showing their relation to general physical problems. 5000 w. Zeitschr d Ver Deutscher Ing—June 4, 1898. No. 21047 D.

Induction.

On the Surface Tension of Liquids under the Influence of Electrostatic Induction. Samuel J. Barnett. Gives a brief discussion of previous work in this field, and describes a method of investigation which has proved more satisfactory than those hitherto employed—the method of ripples in its latest form. 7800 w. Phys Rev—May-June, 1898. No. 20898 D.

Insulation.

Testing the Insulation of Conductors of Street Railways. (Isolations Prüfung von Zeitungen Elektrischen Strassenbahnen.) M. Stobrawa. The perfection of the insulation is tested by the relative brightness of two series of incandescent lamps connected between the collecting bar and the earth circuit. 1200 w. Elektrotech Zeitschr—May 12, 1898. No. 21074 B.

The Effects of Temperature on Insulation Materials. William Esty. Describes tests, apparatus, and methods used in the electrical laboratory of the Univ. of Illinois, to determine the behavior of insulating materials under different physical conditions. 4100 w. Technograph, No. 12—1897-8. No. 20909 D.

Lightning.

Lightning and Lightning Arresters. H. E. Raymond. Gives the results of several years' observations and experiments in the line of protection against damage from atmospheric disturbances. 3800 w. Elec Wld—June 11, 1898. Serial. 1st part. No. 20749.

Magnetic Balance.

Ewing's Magnetic Balance for Workshop Use. (Ewing's Magnetische Wage für den Gebrauch in der Werkstatte.) The methods of calibrating and applying the balance in practical work is discussed. 2000 w. Elektrotech Zeitschr—May 26, 1898. No. 21081 B.

Magnetism.

Effects of Prolonged Heating on the Magnetic Properties of Iron. S. R. Roget. Read before the Royal Society. Reports results of experiments carried out in the laboratory of Cambridge University, investigating an extended range of temperature. 1300 w. Elect'n, Lond—June 3, 1898. No. 20842 A.

Experiments with Koepsel's Apparatus for the Determination of the Magnetic Properties of Iron. (Untersuchungen über den Koepsel'schen Apparat zur Bestimmung der Magnetischen Eigenschaften des Eisens.) Dr. E. Orlich. An account of elaborate investigations made at the Reichsanstalt. The apparatus is a sort of reversal of the d'Arsonval galvanometer. 3000 w. Elektrotech Zeitschr—May 12, 1898. No. 21076 B.

The Reliability of Magnetic Tests Made with a d'Arsonval Ballistic Galvanometer. Samuel Sheldon and Townsend Cocks. Investigations which lead to the conclusion that the results are to be relied upon when the galvanometer is properly manipulated. 1000 w. Elec Wld—June 18, 1898. No. 20852.

Oscillations.

An Experimental Determination of the Period of Electrical Oscillations. Arthur Gordon Webster. Researches concerning the experimental verification of the formula giving the period of the oscillations of an alternating current arising when a charged condenser is discharged through a circuit containing self-induction. Ill. 5000 w. Phys Rev—May-June, 1898. No. 20900 D.

Radiography.

A Simple Explanation of Some Celestial Phenomena by the Cathode Rays. (Explication Simple de Plusieurs Phenomènes Célestes par les Rayous Cathodiques.) A communication to the French Academy from M. H. Deslandres, suggesting an explanation for some of the phenomena of the solar corona during a total eclipse. 1800 w. Comptes Rendus—May 9, 1898. No. 21026 D.

Cathode Rays in an Oscillating Electric Field. Discusses the theory most in favor in England, giving investigations of J. J. Thomson, Jauman, and others, especially explaining the investigations of Prof. Ebert, of Kiel. 2800 w. Elec Rev, Lond—June 3, 1898. No. 20816 A.

On the Fall of Potential at the Surface of a Metal When Exposed to the Discharging Action of the X-Rays. C. D. Childs. An account of experiments made, giving results. 1800 w. Phys Rev—May-June, 1898. No. 20899 D.

Recent Improvements in X-Ray Tubes. H. Lyman Sayen. Discusses "radiant matter" and its properties and briefly describes a tube designed by the writer. 2000 w. Jour Fr Inst—June, 1898. No. 20670 D.

Some New Studies in Kathode and Röntgen Radiations. Alan A. Campbell Swinton. Abstract of discourse delivered at the Royal Inst. Reviews the methods of producing kathode discharges, the theories more generally accepted, late work and results. Ill. 3800 w. Nature—May 26, 1898. No. 20700 A.

The X-Rays and Their Safe Application. J. Mount Bleyer. Read before the Medico-Legal Soc., New York. Notes on precautions necessary in X-ray examinations, and method of treatment when from unforeseen causes an injury has been inflicted. 2000 w. Elec, N. Y.—June 15, 1898. No. 20861.

Rheostat.

The Ferrand Automatic Rheostat. (Rhéostat Automatique, Système J. Ferrand.) The Ferrand rheostat is arranged with discs of carbon of which the resistance is automatically varied by change of pressure. 1200 w. L'Electricien—May 28, 1898. No. 21090 B.

Smelting.

See Mining and Metallurgy, Miscellany.

Switchboards.

Switchboard Reconstruction. Albert B. Herrick. A review of the modern methods adopted in switchboard construction. Ill. 2500 w. Am Elect'n—June, 1898. No. 20765.

Transformers.

Current Transformers. Charles T. Child. Part first shows the necessity of transforming one kind of current into another, and reviews the methods which have been employed, as an introduction to a description of a reversible transformer. 2700 w. Elec Eng, N. Y.—May 26, 1898. Serial. 2 parts. No. 20530 B.

Transformer Economy. Winder Elwell Goldsborough. Abstract of paper read before the Nat. Elec. Lgt. Assn., at Chicago. Discusses the results of a test at Purdue laboratories of a number of transformers of recent design, giving also much information about transformers. 4200 w. Elec Wld—June 25, 1898. No. 21108.

Transformer Regulation. A. R. Everest. Discusses methods of determining the regulation of a transformer. 1800 w. Elec Wld—June 4, 1898. No. 20600.

MARINE ENGINEERING.

High Speed.

A Vessel for High Speed. H. C. Vogt. An investigation of how to obtain high speed on the seas, based on a study of marine animals and their rapidity in swimming. Ill. 2300 w. Steamship—June, 1898. No. 20735 A.

Launch Engines.

The Design and Construction of Small Steam-Launch Engines. Part first considers the requirements of launch machinery, the present tendency in engine design, &c. 1800 w. Mech Wld—May 27, 1898. Serial. 1st part. No. 20699 A.

Marine Engines.

On Taking Charge of a Marine Engine. A. B. Willitts. Presents the leading points to be looked after in taking charge of marine machinery, aiming to aid engineers suddenly called upon. 4500 w. Engr, N. Y.—June 15, 1898. No. 20871.

Marine Plant.

See Electrical Engineering, Power.

Oil Fuel.

Oil Fuel Experiments on Hydraulic Life Boat "Queen." John Platt. A general description of the boat and the results of a series of experiments made burning both coal and oil in a Thornycroft boiler. Ill. 2300 w. Jour of Am Soc of Naval Engs—May, 1898. No. 20680 H.

Repairs.

Marine Engine Repairs. J. Kyles. Read at meeting of the Inst. of Engs and Shipbuilders of Hong Kong. Notes on a few of the most important engine repairs. 5000 w. Steamship—June, 1898. No. 20736 A.

Resistance.

The Determination of the Resistance of Vessels by Experiments with Models. (Die Bestimmung des Schiffswiderstandes auf Grund der Versuche mit Modellen.) A paper by Herr Schromm, discussing the influence exerted by the shape and dimensions of the tank or channel upon the resistance to motion. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—June 10, 1898. No. 21056 B.

Shafts.

The Breaking of Propeller Shafts. (La Rupture des Arbres de Couche.) A discussion of the accidents at sea by reason of shaft breakages, with reference to a large number of recent instances; suggesting methods of repair at sea. 1800 w. La Revue Technique—May 25, 1898. No. 21018 D.

Ship.

The Four-Masted Ship "Kenilworth." Illustrated description of a fine American iron ship. 1200 w. Am Shipbuilder—June 23, 1898. No. 21152.

Steamship.

Details of Largest Wooden Steamship in Commission in the World. Illustrated description of the steamship "Thomas Cranage," a cargo vessel on the Great Lakes. 1500 w. Marine Engng—June, 1898. No. 20716 C.

The Latest North German Lloyd Passenger Steamer. Description of the "Kaiser Friedrich," which has recently made its maiden trip from Bremen to New York. 1000 w. Eng News—June 23, 1898. No. 21119.

U. S. Steamer "Fulton"—Her Design, Construction and Capacity. Charles H. Haswell. An account of the first sea steamer constructed by the U. S. navy. 1000 w. Jour Am Soc of Naval Engs—May, 1898. No. 20684 H.

Twin Screws.

Experiments on the Effect of Direction of Turning in Twin Screws. R. E. Froude. Gives results of model experiments in the comparative efficiency of the two directions of turning. Discussion follows. 2400 w. Jour Am Soc of Naval Engs—May, 1898. No. 20686 H.

Yachts.

American Steam Yachts. Irving Cox. Introductory remarks comparing English and American yachts, with illustrations and brief descriptions of representative craft. 3300 w. Jour of Am Soc of Naval Engs—May, 1898. No. 20681 H.

The High-Speed Steam Yacht as a Factor in Torpedo Boat Design. W. P. Stephens. The first article deals principally with the historical development of the high speed steam yacht, with an account of the successive products of leading builders on both sides of the Atlantic. 4000 w. Engineering Magazine—July, 1898. No. 21-238 B

Yukon Steamers.

Novel Type of Towing Steamers and Barges for Service on the Yukon. Illustrates and describes the eight new boats for the Yukon. They will operate in two fleets, each consisting of one tug, two freight barges, and one passenger barge. 1800 w. Marine Engng—June, 1898. No. 20718 C.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Ordinance.

The New Law in Saxony for Multitubular Boilers. (Le Nouvéau Règlement Saxon pour les Chaudiéres Multitubulaires.) Ch. Bellens. An examination of the recent Saxon regulations, with especial reference to water-tube boilers, giving a sketch of a boiler conforming fully with the official requirements. 1500 w. La Revue Technique—May 10, 1898. No. 21015 D.

Boiler Plant.

The Boiler Plant of Arbuckle Brothers' Sugar Refinery, Brooklyn, N. Y. Illustrated description of plant, noteworthy for the numerous devices for the saving of space, labor and fuel. 900 w. Eng News—June 2, 1898. No. 20614.

Boiler Test.

Tests of a Horizontal Return Tubular Boiler with Two Kinds of High Grade Bituminous Coal. H. Barrus. Describes tests, giving results. 700 w. Eng Rec—June 4, 1898. No. 20651.

Test of an Experimental Boiler. Reports the results of a test made upon curved water legs. Ill. 1700 w. Locomotive—May, 1898. No. 21149.

Corrosion.

The Corrosion of Iron. S. W. Parr and A. E. Paul. Results of a series of experiments conducted for the purpose of determining the conditions favoring the corrosion of iron—or to reproduce as nearly as possible the conditions existing inside of steam boilers. 600 w. Technograph, No. 12—1897-8. No. 20914 D.

Calorimeters.

Steam Calorimeters: Construction, Value and Use to the Engineer. A. H. Eldredge. Presents two of the principal forms of calorimeters for determining the quality of steam, with the methods of using and their importance in boiler trials. Ill. 1500 w. Prac Eng—June 3, 1898. No. 20741 A.

The Determination of Water in Steam. (Die Mengenbestimmung des Wassergehaltes im Kesseldampf.) Ernst Brückner. A very full examination of the various methods of testing moisture in steam, with illustrations of calorimeters, methods of attachment, &c. 12000 w. Zeitschr. d Ver Deutscher Ing—May 28, June 4, 11, 1898. Three articles, No. 21039 each D.

Draft.

Mechanical Draft for Steam Boilers. W. B.

Snow. Presents the economical advantages of mechanical draft, showing it is capable of reducing losses, decreasing the first cost of a steam generating plant, and reducing the fuel expense. 4000 w. Sib Jour of Engng—June, 1898. No. 20675 C.

The Advantages of Mechanical Draft. Walter B. Snow. Presents the general economic advantages, and those relating to the convenience and operation, showing the saving by considering a typical plant. Ill. 3000 w. Am Elect'n—June, 1898. No. 20763.

Economisers.

A Discussion of Economiser Feed Water Heaters. (Note sur les Economisers-Réchauffers d'Eau.) A general examination of the performance of economisers, showing the extent to which economy may be expected, and indicating the most effective arrangement. 6000 w. 1 plate. La Revue Technique—May 25, June 10, 1898. Two articles. No. 21017 each D.

Explosion.

The Fatal Boiler Explosion at Bury. Gives the investigations by the Board of Trade into the causes and circumstances. The tramways company are severely blamed. Also editorial. 3000 w. Prac Eng—June 17, 1898. No. 21200 A.

Fuel Test.

The Examination of Combustible Minerals by X Rays. (Examen d'un Combustible Minéral au Moyen des Rayons de Röntgen.) A note by M. Couriol, showing that combustible materials are transparent, and non-combustible, opaque to X rays, and that the purity of a fuel can be determined instantly in this manner. 800 w. Compte Rendus—May 31, 1898. No. 21032 D.

Oil Filter.

An Oil Filter for Boiler Feed Water at Peoria, Ill. Dabney H. Maury, Jr. Read before the Buffalo convention of the American Water-Works Assn. An account of the various experiments tried and the final success, with statement of conditions under which the filters and boilers were operated. Ill. 2800 w. Eng News—June 23, 1898. No. 21117.

Repairs.

See Shop and Foundry.

Riveted Seams.

Defects in Riveted Seams of Boilers. (Etude sur les Avaries de Certaines Chaudières dans la Region des Rivures Circulaires.) Ch. Frémont. A discussion of the causes of cracks along longitudinal riveted seams, with photographic illustrations. 1500 w. Bulletin de la Societé d'Encour—May, 1898. No. 21035 G.

Stoker.

Proctor's Mechanical Stoker. Illustrated description of a design the chief feature of which is a ram, or impeller, for the fuel, which is worked with a horizontal reciprocating motion by means of cams and levers. 1800 w. Engng—June 20, 1898. No. 20955 A.

Vertical Boiler.

A Vertical Steam Boiler of Novel Design. Illustrated description of an internally fired vertical tubular boiler designed by Dean and Main. 600 w. Eng News—June 23, 1868. No. 21118.

Water-Heater.

Notes on a Water-Heater at Cadzow Colliery. William S. Thomson. Read before the Mining Inst. of Scotland. Illustrated description with advantages gained. 900 w. Col Guard—June 17, 1898. No. 21178 A.

Water-Tube.

A New Water-Tube Boiler. Illustrates and describes what is known as the "Johnston" water-tube boiler, manufactured by the Brownell Co., of Dayton, Ohio. 1000 w. Eng News—June 2, 1898. No. 20613.

Novel Arrangement of Feed-Water Heater in Water-Tube Boilers. A. F. Yarrow. Describes experiments made which prove the advantage of the new feed system. Discussion. 4300 w. Jour Am Soc of Naval Engs—May, 1898. No. 20683 H.

COMPRESSED AIR.

Compressors.

Air Compressors at High Altitudes. F. A. Halsey. Shows that the air produced is not proportional to the barometric pressure, and the value of compound compressors in such locations. 1300 w. Am Mach—June 2, 1898. No. 20632.

Diagrams.

Diagrams for Compressed Air.—Horse-Power and Temperature. J. E. Johnson, Jr. Diagrams platted to supply a quick and convenient means of obtaining fairly accurate solutions of these two questions in connection with compressed air. 2000 w. Am Mach—June 23, 1898. No. 21112.

Motors.

Compressed Air Motors. Describes in detail the distinctive features of the Hoadley-Knight system of street-railway operation. Ill. 2800 w. Compressed Air—May-June, 1898. No. 20564.

See also Municipal Engineering, Water Supply.

ENGINES AND MOTORS.

Compound Engines.

Engines of the Ferry Steamer Chebucto. Illustrated description of the driving-engines and other machinery. 700 w. Engr, Lond—May 20, 1898. No. 20577 A.

Non-Condensing Compound Engines for Office Buldings. Editorial discussion of their value compared with simple engines. 1600 w. Eng Rec—June 18, 1898. No. 20933.

The Effect of Size upon the Economy of Compound Engines. An analysis of comparable tests showing large cylinders to give from 2 to 5% better results. 500 w. Eng Rec—June 4, 1898. No. 20642.

Diesel Motor.

The Merits of the Diesel Motor. From the paper of Aimé Witz to the Academy of Science. Notes that the absolute efficiency remains the same whatever the work may be, and the value of this property. 700 w. Automotor Jour—June 15, 1898. No. 21204 A.

Entropy.

Entropy and Temperature-Entropy Diagrams. W. F. Durand. Showing that entropy should be considered as a relation rather than a property, and explaining very fully the method of constructing and using the temperature-entropy diagram for any given case. 12800 w. Jour Am Soc of Naval Engs—May, 1898. No. 20-678 H.

Gas Engines.

Marine Gasoline and Gas Engines as Used in Modern Motor Boats. Cecil H. Peabody. A statement of the principle of these engines and the difficulties in their design and construction. 2600 w. Marine Engng—June, 1898. Serial. 1st part. No. 20717 C.

See Municipal Engineering, Water Supply.

Gas Power.

Gas Power and Electricity. (Gaskraft und Elektrizität.) A discussion of the relative merits of gas and electric motors; also of the economy of gas engines for the driving of electric generators. 4000 w. Zeitschr d Ver Deutscher Ing—May 28, 1898. No. 21043 D.

Gas Power. J. E. Dowson. Read at meeting of the Fed. Inst. of Min. Engs., London. Gives a historical sketch of gas engines, the alterations and improvements, the trials and cost of maintenance. 2300 w. Ir & Coal Trds Rev—May 20, 1898. No. 20566 A.

Governors.

Steam Engines with Shaft Governors. (Dampfmaschinen mit Flachreglern.) Hugo Seidler. An illustrated discussion showing forms of shaft governor used in Germany, with diagrams showing the closeness of regulation. 4000 w. Zeitschr d Ver Deutscher Ing—May 14, 1898. No. 21-036 D.

The Shaft Governor. Henry E. Longwell. A discussion of Prof. Carpenter's article with notes from the writer's experience. 2200 w. Power—June, 1898. No. 20627.

The Shaft Governor. Thomas Hall. Considers some of the problems presenting themselves in the endeavor to secure good regulation. Ill. 3500 w. Elec Wld—June 4, 1898. No. 20601.

Link Motion.

The Distribution of Work in Compound Engines by the Link Motion. (Die Arbeitsverteilung bei Verbundmaschinen mit Kulissensteuerung.) W. Schwarz. Giving a graphical method for determining the work performed at various points of cut-off. 1000 w. Zeitschr d Ver Deutscher Ing—May 28, 1898. No. 21042 D.

Pistons.

Packing Piston Rods. W. H. Wakeman. Gives points on the packing and oiling of piston rods. 800 w. Am Mach—June 23, 1898. No. 21113.

Pumping Engine.

The Holst Pumping Engine. Illustrates and describes a new system of pumping engine designed by C. P. Holst, of Amsterdam, Holland. The water flows in a constant stream. 1000 w. Am Mach—June 9 1898. No. 20757.

Steam Economy.

The Economical Use of Steam in Non-Condensing Engines. James B. Stanwood. A discussion of the economy which may be obtained by the throttling compound non condensing engines as compared with the automatic cut-off type. 3000 w. Engineering Magazine—July, 1898. No. 21236 B.

Steam Turbine.

Parson's Patent. Report of the proceedings of the Judicial Committee of the Privy Council in regard to the extension of the patent of Charles Algernon Parsons for steam turbines, with editorial. 3300 w. Engr, Lond—May 20, 1898. No. 20579 A.

Stopping Device.

An Automatic Device for Stopping Engines. Illustrates an apparatus, worked by electricity from any part of a shop. 1200 w. Eng Rec—June 18, 1898. No. 20938.

Traction Engines.

Latest Types of American Traction Engines. William Fletcher. A brief comparison of some of the best American traction engines with the road engines manufactured in England, with description of American types. Ill. 2500 w. Engr, Lond—June 10, 1898. Serial. 1st part. No. 20965 A.

Valve Diagram.

The Application of the Double Valve Diagram. (Ein Beitrag zur Beurtheilung der Zweischiebersteuerung.) K. Gelinek. A discussion of the application of the Müller valve diagram to slide valve gears with cut-off valve operated by a separate eccentric. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—May 27, 1898. No. 21053 B.

Valve Diagrams for Corliss Valve Gear. (Schieberdiagramme für Corlisssteuerungen.) A Seemann. Showing how the Müller valve-diagram may be applied to the Corliss engine, giving accurate results with little labor. 2500 w. Zeitschr d Ver Deutscher Ing—June 11, 1898. No. 21044 D.

Valves.

Piston Valves. W. Reviews the experience gained in developing the piston valve as used in locomotive engineering, showing that it may or may not be as well balanced as a slide valve, 1100 w. R R Gaz—June 10, 1898. No. 20793.

Vertical Engines.

Vertical and Horizontal Engines for Stationary Plants. (Stehende und Liegende Dampfmaschinen für Stationare Anlagen.) R. A. Zeise. Showing the constructive and operative advantages of vertical engines. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—May 28, 1898. No. 21040 D.

POWER AND TRANSMISSION.

Gas Plant.

See Electrical Engineering, Power.

Power Plants.

See Electrical Engineering, Power.

Power Gas.

The Application of Furnace Gases for the Direct Generation of Power. (Verwendung der Hochofengase zur Unmittelbaren Krafterzeugung.) F. Lürmann. A general review of the results obtained at Seraing and Wishaw and of the discussion at the meeting of the Iron and Steel Institute. 7500 w. Stahl und Eisen—June 1, 1898. No. 21073 D.

The Utilization of Blast Furnace Gas. (De l'Emploi des Gaz de Hauts Fourneaux.) A discussion of the results obtained with blast furnace gases in gas engines at Seraing, Belgium, and Wishaw, Scotland. 3000 w. Le Génie Civil—May 21, 1898. No 21002 D.

The Utilization of Blast Furnace Gases. (De l'Utilisation des Gaz des Hauts Fourneaux.) H. Hubert. A discussion of the chemical and thermal features of the problem in the light of the experience at Seraing. 2500 w. Revue Universelle des Mines — May, 1898. No. 21095 H.

The Utilization of Blast Furnace Gases. (De l'Emploi des Gaz de Hauts-Fourneaux.) A. Greiner. A detailed report of the results of the use of blast furnace gases in gas engines, at the Cockerill Works at Seraing, Belgium, by the General Manager of the company. 3000 w. Revue Universelle des Mines—May, 1898. No. 21096 H.

Water Power.

Water Power Plant at the "Soo." Gives general description of the construction of a plant at Sault Ste. Marie, Mich., for which tenders are invited. 1200 w. Ry & Engng Rev—May 28, 1898. No. 20562.

SHOP AND FOUNDRY.

Automatic Valve.

An Automatic Stop Valve. (Sur une Valve-Clapet Automatique d' Arret.) The Groignard valve can be opened by hand, and will remain open until closed, unless the pipe should burst in which case it closes automatically by the action of the escaping steam. 1200 w. Bulletin de la Société d'Encour—May, 1898. No. 21034 G.

Self-Acting Stop and Regulating Valves. (Selbstthätiges Absperr-und Regel-Ventil.) Describing and illustrating several forms of the Koch automatic stop valve, which closes of itself if a burst pipe permits an escape of steam. 2000 w. Zeitschr d Ver Deutsher Ing—June 4, 1898. No. 21048 D.

Bearings.

Roller Bearings. W. B. Marshall. Read at meeting of the Fed. Inst. of Min. Engs., London. Shows the difference between rolling and sliding motion, states the requirements of a satisfactory roller bearing, giving some results obtained from their application. 3000 w. Ir & Coal Trds Rev—May 20, 1898. No. 20565 A.

Brass.

A Talk on Brass Founding. Charles Vickers. Read at Cincinnati meeting of Am. Foundrymen's Assn. Considers methods used in various classes of work to secure the best results. 1600 w. Ir Age—June 16, 1898. No. 20858.

Brass Foundry Practice. K. K. Gives illustrated description of methods used and found capable of producing good results. 1300 w. Foundry—June, 1898. No. 20674.

Buildings.

Incombustible Foundry Buildings. O. Benson. Read at Cincinnati meeting of the Am. Foundrymen's Assn. Presents the advantages of steel construction and compares the cost with the wooden structure. Ill. 1600 w. Ir Trd Rev—June 23, 1898. No. 21154.

Castings.

Inspection of Castings. E. H. Putnam. Read at the Cincinnati meeting of the Am. Foundrymen's Assn. Emphasizes the importance of thorough inspection, as early as possible after the casting is made. 1200 w. Ir Trd Rev—June 23, 1898. No. 21153.

Necessity of Well Mixed Furnace Casts and Correct Pig Iron Analyses. Thomas D. West. Read at Cincinnati meeting of Am. Foundrymen's Assn. Advises the use of chemical analysis, and discusses the need of uniform casts of pig iron, and how to obtain them. 1600 w. Ir Age—June 16, 1898. No. 30859.

Straightening Crooked Castings. R. H. Palmer. Discusses some of the causes of crooked castings and means of straightening them. 1600 w. Foundry—June, 1898. No. 20673.

The Manufacture of Steel Castings. Stewart Johnston. Read at Cincinnati meeting of the Am. Foundrymen's Assn. A brief review of the methods employed, with some of the uses. 3000 w. Am Mfr & Ir Wld—June 10, 1898. No. 20798.

Curved Surfaces.

The Fitting of Curved Surfaces. Some suggestions for this work showing the principles involved. 1000 w. Prac Eng—June 3, 1898. No. 20740 A.

Dividing Wheel.

The R. Hoe & Co.'s Dividing Wheel. John Randol. Illustrates and describes the construction and manner of use of a dividing wheel believed to be absolutely true, in a machine shop sense, and to have no measurable variations in its spacing. 1800 w. Am Mach—June 2, 1898. No. 20633.

The Thorne Mechanically Originated Dividing Wheel. John Randol. Illustrated description of a dividing wheel of cheap construction that produces excellent work. 1000 w. Am Mach—June 9, 1898. No. 20756.

Gears.

Cutting Bevel Gears. J. M. Lynch. What a workman should know in order to cut bevel gears with a rotary cutter. Ill. 2800 w. Mach, N. Y —June. 1898. No. 20617.

Cutting Bevel Gears with Correct Teeth. Gives illustrations with brief descriptions of the most prominent machines used in accurate bevel gear cutting. 1500 w. Mach, N. Y.—June, 1898. No. 20615.

Spiral Gearing. W. H. Van Dervoort. How to design and cut spiral gears. Ill. 3500 w Mach, N. Y.—June, 1898. No. 20618.

The Mechanism of Gear-Cutting Machines. L. D. Burlingame. Part first deals with indexing for gear-cutting, and considers the styles of indexing mechanism most commonly in use, and the methods to insure accuracy. 2800 w. Mach, N. Y.—June, 1898. No. 20616.

Hardness.

A Test for Hardness of Cast Iron. Charles A. Bauer. Read at the Cincinnati meeting of the Am. Foundrymen's Assn. Describes a test by the use of a drill press, which is believed to be reliable and of practical value. 800 w. Ir Trd Rev—June 9, 1898. No. 20758.

Indicator.

A New Inertia Indicator. Wilfred Lewis. Read before the Engs.' Club of Phila. Describes a convenient device for measuring inertia effects, stating how it came in use and some of its useful applications. Ill. 1600 w. Am Mach—June 23, 1898. No. 21111.

Lathe Dogs.

Automatic Equalizing Lathe Dogs. (Ueber Selbstthätig-Ausgleichende Mitnehmer.) Herman Fischer. Illustrating various methods of driving work by which the turning pressure may be equalized. 2000 w. Zeitschr d Ver Deutscher Ing—May 28, 1898. No. 21041 D.

Milling Machine.

Vertical Milling Machine for Locomotive Cylinders. (Wagerechte Fräsmaschine für Lokomotivcylinder.) M. Fröhlich. Illustrated description of a powerful new milling machine built by the Alsace Machine Works for the Berlin Machine Tool Co. It is driven by a 5½ h. p. electric motor. 1000 w. Zeitschr d Ver Deutscher Ing—June 11, 1898. No. 21045 D.

Molders.

The Molder of the Future and the Need of an Adequate Apprenticeship System. P. W. Gates. Read at the Cincinnati meeting of Am. Foundrymen's Assn. Discussing means of securing desirable apprentices. 2300 w. Ir Age—June 16, 1898. No. 20857.

Pipe.

Specifications for Cast-Iron Pipe. P. D. Wanner. Abstract of paper read before the Am. Water-Works Assn. Recommendations of an experienced foundryman as to the best methods of making cast-iron pipe and the specifications for the material. 1200 w. Eng Rec—June 25, 1898. No. 21164.

Repairs.

How to Put on a New Boiler, Fit Up Spring Hangers, Driving Saddles, etc. Ira A. Moore. Considers the subjects mentioned, giving illustrations. 1100 w. Loc Engng—June, 1898. No. 20693 C.

Rivet Steel.

The Shearing Strength of Rivet Steel. Arthur N. Talbot. Presents the results of a series of tests made in the Laboratory of Applied Mechanics of the Univ. of Illinois. Ill. 1800 w. Technograph, No. 12—1897-8. No. 20916 D.

Shop Costs.

Effective Systems of Finding and Keeping Shop Costs. Henry Roland. Describing the method used at the Newton Machine Tool Works, Philadelphia, with accounts of the time keeping system, book forms, tickets, etc. 3500 w. Engineering Magazine—July, 1898. No. 21237 B.

Steel Works.

The Works of the Schoen Pressed Steel Company. Account of these works with illustrations of shops and products. 1600 w. R R Gaz—June 10, 1898. No. 20795.

Tempering.

Tempering by Color. B. F. Spalding. Considers ornamental bluing, methods of heating, tempering sewing machine needles, knife section coloring, gas fuel furnaces, regulation of heat, etc. 2400 w. Am Mach—June 2, 1898. No. 20631.

Test Bars.

The Adoption of a Standard System of Test Bars for Cast Iron. Richard Moldenke. Read before the Am. Foundrymen's Assn., at Cincinnati. Describes the practice of testing in Germany, and discusses the subject in general, urging practical action by the association. 4300 w. Ir Trd Rev—June 9, 1898. No. 20759.

Trolley System.

Trolley Systems—Their Value in Foundry Work. Herbert M. Ramp. Presented at the Cincinnati meeting of the Am. Foundrymen's Assn. Calling attention to some of the good points and advantages of this system. 1900 w. Am Mfr & Ir Wld—June 24, 1898. No. 21219.

Welding.

Welding of Metals. F. V. M'Mullin. States the requirements for a good weld, the methods of welding, etc., and explains why most metals are unweldable. 1600 w. Sib Jour of Engng—June, 1898. No. 20677 C.

MISCELLANY.

Aeronautics.

The Practicability of Long Aerial Voyages. (De la Possibilité des Voyages Aeriéns au Long Cours.) A discussion of the possibility of investigating the interior of the Sahara and the Soudan by means of a balloon, with the mechanical features of the apparatus. A detailed examination of the problem is given. 6000 w. La Revue Technique—May 10, 1898. No. 21012 D.

Animal Mechanics.

Chronophotography Applied to the Study of Muscular Action in Locomotion. (La Chronophotographie Appliquée à l'Etude des Actes Musculaires dans la locomotion.) An important communication by M. Marey, analyzing the mechanical motions of the horse by continuous photography. 3500 w. Comptes Rendus—May 23, 1898. No. 21030 D.

Automobiles.

Gearing for Automotors. Rhys Jenkins. Some of the most interesting schemes for transmitting the motion of the motor to the driving wheels are briefly noticed. 900 w. Automotor Jour—June, 1898. No. 21203 A.

Light Oil Motors. John Henry Knight.

Presents the advantages and disadvantages of petroleum spirit in motor-cars, with brief discussion of electrical firing. 1500 w. Automotor Jour—June 15. 1898. No. 21206 A.

Motor-Vehicle Trials at Birmingham. Illustrated account of the second of the annual trials of the heavy automotors. 1400 w. Automotor Jour—June 15, 1898. No. 21205 A.

Motor Wagons. Illustrated description of two vehicles that have been entered for the competition at Liverpool, under the auspices of the Self-Propelled Traffic Assn. 1100 w. Engng—May 20, 1898. No. 20581 A.

Motor Wagon Trials at Liverpool. Illustrated description of the four vehicles which competed. 2000 w. Engr, Lond—May 27, 1898. No. 20706 A.

Motor Wagon Trials at Liverpool. Profile and maps of the routes traversed, with additional information of results. 700 w. Engr, Lond—June 3, 1898. No. 20826 A.

Steam Vehicles for Heavy Traffic. Editorial discussion of the recent competition at Liverpool. Thinks the experiments so far are encouraging for goods traffic by motor wagons. 2200 w. Engng—May 27, 1898. No. 20712 A.

Steam Vehicles for Heavy Traffic. Further account of the trials at Liverpool giving the results obtained in the last three days. 2300 w. Engng—June 3, 1898. No. 20830 A.

The Automobile Vehicles of the Northern Railway of France. (Les Voitures Automobiles du Chemin-de-Fer du Nord.) An account of the steam and electric cabs operated in connection with the Paris terminal of the Northern Railway of France. 2500 w. Moniteur Industrielle—May 28, 1898. No. 21061 G.

The Liverpool Trials of Heavy Motor Vehicles. A statement of the conditions, and full account of the trials, the routes traveled, the vehicles, &c. Ill. 15000 w. Automotor Jour—June 15, 1898. No. 21202 A.

The Scotte System of Automobile Vehicles. (Les Voitures Automobiles, Système J. Scotte.) An illustrated description of the Scotte steam omnibus, now successfully used for regular suburban road service in France. 2000 w. 1 plate. La Revue Technique—May 10, 1898. No. 21013 D.

Bicycle Motor.

Bicycle with Rotary Petroleum Motor. (Bicyclette à Pétrole à Moteur Rotatif.) Illustrating and describing an improved form of petroleum motor bicycle, which has given good results in practice. 1500 w. La Revue Technique—June 10, 1898. No. 21022 D.

Bicycles.

The Evolution of the Cycle. W. K. Starley. Introductory remarks upon locomotion generally, followed by a review of the types of cycles, describing the principles and parts of the machine which are still in use to-day. Discussion. 12000 w. Jour Soc of Arts—May 20, 1898. No. 20568 A.

The Form and Construction of Bicycles. (La Bicyclette. Historique,—Forme—Construction.) A general account of the development of the bicycle from the early hobby-horse to the modern machine, with many illustrations. 700 w. Le Génie Civil—May 28, June 4, 11, 1898. Three articles. No. 21005 each D.

Cable Testing.

Tension Test of a Wire Cable of 90 m m Diameter. (Prüfung eines Drahtseiles von 90 mm. Durchmesser auf Zugfestigkeit.) Prof. A. Martens. An interesting account of the test of this heavy cable, with photographic views of the machine and arrangements. 1800 w. Mitt aus d Kgl Tech Versuchsanstalt—Part 2, 1898. No. 21070 G.

Chimney.

The Destruction of a Tall Chimney. (Die Niederlegung eines Stohen Schornsteins.) Description of the removal of a chimney of 20 feet base diameter, and 260 feet high, by the explosion of charges of roburite in holes drilled in one side at the base. Instantaneous photographs are given of successive stages of the fall. 1000 w. Zeitschr d Ver Deutschr Ing—June 11, 1898. No. 21046 D.

Conveying Machinery.

The Design of Elevating and Conveying Machinery. J. V. E. Schaefer. Illustrated description of machinery for the handling of material by means of elevators and conveyors, as shown in the designs used by the Link Belt Machinery Co., of Chicago. 4500 w. Technograph, No. 12—1897-8. No. 20910 D.

Coupling.

Pipe Coupling. Describes a coupling brought out by Andrew J. Avery, of Dunkirk, N. Y., which is both gas and water tight under all pressures. 600 w. Bos Jour of Com—June 4, 1898. No. 20639.

Drawing.

Drawing and Drawing Instruction. (Das Zeichnen und der Zeichnenunterricht.) A paper by H. Pickersgill on the methods of teaching drawing in connection with engineering instruction. 5000 w. Zeitschr d Ver Deutschr Ing—June 4, 1898. No. 21049 D.

Hydraulics.

The Flow of Water in a Six-Foot Conduit. An analysis of recent experiments showing possible defects in Kutter formula when used for large steel and wood pipes. 1100 w. Elec Rec—June 4, 1898. No. 20643.

Kites.

Kites: Their Theory and Practice. B. F. S. Baden-Powell. The personal experiences of the writer who has given much time to researches in this line, giving a summary of results of experiments. Ill. 3500 w. Sci Am Sup—June 4, 1898. Serial. 1st part. No. 20689.

Laundry Machinery.

Steam Laundry Machinery. Sidney Tebbutt. Read before the Inst. of Mech. Engs., England. Part first considers briefly the arrangement of the laundry, and method of washing, but is largely a description of washing-machines. Ill. 4500 w. Engng—June 17, 1898. Serial. 1st part. No. 21184 A.

Liquefaction.

The Liquefaction of Hydrogen and Helium.

(Sur la Liquéfaction de Hydrogène et de l'Helium.) The original communication to the French Academy by Prof. Dewar, communicated by M. Moissan. 2400 w. Comptes Rendus—May 16, 1898. No. 21029 D.

Oil Testing.

Determination of the Value of Lubricants, Especially Spindle Oil, by a New Oil Tester. (Wertbestimmung von Schmierölen, besonders von Spindelölen, mit Einem Neuen Oelprüfer.) Dr. Sigmund Kapff. A loaded spindle is rotated by an electric motor, and the electric power required is used to measure the value of the lubricant. 3500 w. Zeitschr d Ver Deutscher Ing—May 14, 1898. No. 21037 D.

Rock-Crusher.

A Large Rock-Crusher and Crushing Plant. Describes a very large machine put upon the market by the Gates Iron Works, of Chicago. It has a capacity of 200 tons per hour. Also gives a record from the president of the Pittsburg Limestone Co. of 14 months work. Ill. 1000 w. Eng News—June 16, 1898. No. 20881.

Rubber.

The Reclaiming of Old Rubber. Hawthorne Hill. An account of the progress made in reclaiming rubber from worn-out goods in a condition fit for use again, with information concerning the product. 3700 w. Sci Am Sup—June 25, 1898. No. 20995.

Stamp Mill.

Morison's Quick-Running Stamp Mill. Illustrated description. 900 w. Engng—June 3, 1898. No. 20831 A.

Standards.

Uniformity of Standard. John A. Grier. Showing the importance and convenience of a standard of weights and measures, and of other standards used in business. 2000 w. Prac Eng—June 3, 1898. No. 20739 A.

Thermodynamics.

A New Method for the Determination of the Mechanical Equivalent of Heat. (Methode Nouvelle pour Determiner l'Equivalent Mécanique de la Chaleur.) A method by MM. Baille and Féry, in which the elevation in temperature is measured of a metallic mass fixed in an alternating electrical field. 1000 w. Comptes Rendus—May 23, 1898. No. 21031 D.

Wire Rope.

Impact Tests on Wire Rope. Charles F. Hamilton. Describes tests and comparison with tensile strengths. 800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21128 D.

Wood Screws.

Experiments and Study upon the Holding Power of Wood Screws. Norris M. Works. Reports a series of experimental tests and the conclusions. 2000 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21126 D.

MILITARY ENGINEERING.

Artillery.

Cannon of Large Calibre. (Canons de Gros Calibre.) A discussion of the value of guns of various calibre as shown in the recent Spanish-American naval engagement at Manila. 1800 w. La Revue Technique—June 10, 1898. No. 21021 D.

Battleship.

H. M. S. Albion. Illustrated description of a vessel recently launched, with her equipment. 800 w. Engr, Lond—June 17, 1898. No. 21187 A.

Wanted: Faster Battleships. Editorial protest against the action of the Board of Construction of the Navy Department in deciding that the three new battleships provided for by the U. S. Congress should have speeds of only 15 or 16 knots. Also reviews the fast battleships of foreign nations. 2800 w. Eng News—June 23, 1898. No. 21120.

Camp Equipments.

New Camp Equipments for the German Army. From *Illustrirte Zeitung*. Cooking tent and its furnishings, stable tent, hospital appliances, officers' tents, &c., are illustrated. 500 w. Sci Am Sup—June 18, 1898. No. 20867.

Cruiser.

Recent Trials of the Cruiser "Diadem." John Durston. Report of the trials and their results which show that the engines and boilers are economical and efficient for warship service. Discussion. 4800 w. Jour Am Soc of Naval Engs—May, 1898. No. 20685 H.

The Boilers and Bulkhead Doors of the "Chicago." Illustrated description of the changes made in this vessel to convert her into a fast cruiser, with special attention to the system for closing the bulkhead doors in an emergency. 1500 w. Sci Am—June 25, 1898. No. 20993.

The Chilian Cruiser "O'Higgins." Illustration with important particulars of this recently completed vessel. 800 w. Engng—May 27, 1898. No. 20709 A.

The Japanese Cruiser Takasago. Illustrated description of the latest development of second-class cruiser, as regards armament and propelling machinery. A noticeable feature is the absence of excessive superstructure and the very modest proportion of cowls. 700 w. Engr, Lond—June 3, 1898. No. 20827 A.

The Machinery of H. M. S. "Europa." Illustrates and describes the main propelling engines and other machinery, giving an account of her official steam trials. 2700 w. Engng—June 10, 1898. No. 20956 A.

Trials of Dutch Cruisers. Gives results of trials of three vessels of the Dutch navy, which were fitted with a combination of small tube, or express water-tube boilers and return tube boilers, giving also details of the vessels. 800 w. Engng—June 3, 1898. No. 20833 A.

Explosives.

Submarine Mines. George N. Crouse. De-

scribes the construction and operation and their effects. The best methods for harbor protection and the requirements. Ill. 2000 w. Yale Sci M—June, 1898. No 20901 C.

Field Telephones.

See Electrical Engineering, Telephony.

Guns.

Our New Thirteen-Inch Guns. Illustrates and describes this gun, twenty-eight being in use in the U. S. navy. 1200 w. Sci Am—June 11, 1898. No. 20745.

Vickers' Guns. Illustrated description of the breech mechanism of guns manufactured by Messrs. Vickers, Sons, and Maxim, Limited, England. 2500 w. Engng—May 20, 1898. No. 20580 A.

Japanese Navy.

The Sea Power of Japan. Comments on the relation of Japan to the other Powers, her progress, and her aim to possess a strong enough fleet to guarantee against attack. A brief review of the present navy is given; with ships now building. 2400 w. Engng—May 20, 1898. No. 20583 A.

"Maine."

The Destruction of the United States Battleship "Maine." J. T. Bucknill. An examination and criticism of the work of the Court of Inquiry, with the aim of arriving at the truth concerning the disaster. 2100 w. Engng—May 27, 1898. Serial. 1st part. No. 20708 A.

Mining.

Rapid Mining System for Defense of Fortifications. (Nouveau Procédé de Construction Rapide des Galeries de Mines pour la Défense des Forteresses.) A form of portable wooden shield is used to enable military tunneling to be rapidly and successfully done. 1500 w. 1 plate. Le Génie Civil—June 11, 1898. No. 21009 D.

Sea Power.

Sea Power at the End of the Nineteenth Century. W. Laird Clowes. A full discussion of the various factors included in sea power, showing above all things the supreme importance of speed. 5000 w. Engineering Magazine—July, 1898. No. 21230 B.

Smokeless Powder.

Smokeless Powder. Editorial, calling attention to the disadvantages the American navy have to contend with from not being provided with smokeless powder. 1000 w. Sci Am—June 11, 1898. No. 20744.

The Maxim-Schüpphaus Smokeless Powder. Some further information concerning this powder and its method of combustion. Ill. 3500 w. Engng—June 10, 1898. No. 20958 A.

Torpedo Boats.

The Submarine Torpedo Boat Plunger. J. Alvah Scott. Illustrated description of the boat and its equipment. 3000 w. Jour of Am Soc of Naval Engs—May, 1898. No. 20679 H.

The U. S. Torpedo Boat "Morris." H. G. Gillmer and M. A. Anderson. Description with report of trial. 1700 w. Jour Am Soc of Naval Engs—May, 1898. No. 20688 H.

The United States Torpedo Boats "Talbot" and "Gwin." M. A. Anderson and H. G. Gillmor. Description with dimensions and report of trials. 2000 w. Am Soc of Naval Engs—May, 1898. No. 20687 H.

Torpedo Tubes.

Torpedo Discharge Tubes. A report and description recently prepared by Sir William Armstrong, Whitworth & Co. of their new torpedo discharge tube. Ill. 2500 w. Engr, Lond—May 27, 1898. No. 20704 A.

U. S. Navy.

The Navy of the United States. Henry W. Raymond. Reviews the fighting capacity of the naval force, and considers the different classes in detail, with interesting comments. Ill. 3000 w. Chau—June, 1898. No. 20548 C.

War Operations.

The Conduct of the War. Gives a leading article from the London *Engineer*, containing comments and criticisms of the military and naval operations of the war between the U. S. and Spain, with editorial reply. 3500 w. Eng News—June 16, 1898. No. 20879.

MINING AND METALLURGY.

COAL AND COKE.

Cape Breton.

Notes on the Recent Discovery of Coal near Cochrane's Lake, C. B. E. T. Moseley. An address before the Mining Society of Nova Scotia. An estimated addition of one-thousand millions tons of coal. 1800 w. Can Min Rev—May, 1898. No. 20595 B.

Coal Cutting.

Coal Cutting by Machinery. W. T. Goolden. Read before the Fed. Inst. of Min. Engs., England. Abstract with discussion. Shows that a greater variety of machines are needed to meet special conditions. From the electrical system. 4700 w. Ir & Coal Trds Rev—May 27, 1898. No. 20697 A.

Coal Mines.

The Mines of the Consolidation Coal Company. Illustrated description of the mines of this company of Baltimore, Md., and its transportation facilities. 2000 w. Ir & Coal Trds Rev—June 10, 1898. No. 20954 A.

Coal Supply.

Coal in the East. From the *Statist*. Calls attention to the new coal seams being opened in China, Chili, Siberia, etc., and the changes being wrought by their discovery. 1600 w. Engr, Lond—June 10, 1898. No. 20968 A.

Contraband.

Coal as Contraband of War. Gives information of jurists and others respecting contraband of war generally, and the penalty of carrying it,

with some discussion of the decision regarding coal, as given by the English Home Secretary to the Lords of the Admiralty. 2800 w. Col Guard—May 20, 1898. No. 20589 A.

Durham.

Impressions of Durham Coal Mining on a Lancashire Man. Arthur Mort. Notes on the mining practice in this district, the result of a recent visit. 2800 w. Col Guard—May 27, 1898. No. 20715 A

El Paso.

The El Paso Coal Field. Arthur Lakes. Report on a new and valuable coal field near Colorado Springs, Colorado. Ill. 1400 w. Mines & Min—June, 1898. No. 20722 C.

Storage.

Coal Storage. Charles Piez. The different methods of storing and handling the steam sizes of anthracite coal. The reasons for storage, describing the advantages and disadvantages of the various sytems in use, and the cost of operating and constructing them. Ill. 3500 w. Mines & Min—June, 1898. No. 20723 C.

COPPER.

Copper Field.

Chillagoe, Queensland, Australia. Interesting particulars of this great copper field. 1500 w. Aust Min Stand—May 12, 1898. No. 21207 B.

Copper-Mattes.

The Elimination of Impurities of Copper-Mattes in the Reverbatory and Converter. Edward Keller. Discussion of this paper presented at the Atlantic City Meeting, Feb., 1898. 1500 w. Trans of Am Inst of Min Engs—June, 1898. No. 21142 D.

Electrolytic Assay.

The Electrolytic Assay as Applied to Refined Copper. Additional discussion of George L. Heath's paper, presented at the Lake Superior meeting, July, 1897. 2800 w. Trans Am Inst of Min Engs—June, 1898. No. 21140 D.

Production.

Copper Production in 1897. The output in the United States, reached the highest point ever attained. 900 w. Eng & Min Jour—June 25, 1898. No. 21169.

GOLD AND SILVER.

Alluvial Mining.

Alluvial Gold Mining at Edmonton, Alberta, Canada. Isaac Cowie. An account of the mineral wealth of this region, the methods of mining employed, and general information of interest. 3400 w. Can Min Rev—May, 1898. No. 20594 B.

Assays.

Scorification and Cupellation Without Muffle.—A New Furnace and Method for Gold and Silver Assays. George A. Koenig. Describes a new departure in assaying, the furnace used, and the process. Ill. 5800 w. Trans of Am Inst of Min Engs—June, 1898. No. 21147 D.

Auriferous Lodes.

The Genesis of Certain Auriferous Lodes. Discussion of the paper by Dr. John R. Don, presented at the Chicago meeting, Feb., 1897. 4500 w Trans of Am Inst of Min Engs—June, 1898. No. 21139 D.

British Columbia.

British Columbia Mines in 1897. William A. Carlyle. An interesting report of this region showing the gratifying progress and steady growth. 3300 w. Eng & Min Jour—June 4, 1898. No. 20654

Mining and Transportation. William M. Brewer. Some of the methods practiced in British Columbia and the conditions of geography and climate which necessitate them. 1800 w. Mines & Min—June, 1898. No. 20727 C.

The Sandon District. W. M. Brewer. Brief review of the mines of this district in British Columbia. 1800 w. Eng & Min Jour—June 18, 1898. No. 20946.

Cassel-Hinman Process.

The Cassel-Hinman Gold and Bromine Recovery Process. Editorial discussion of this new process, considering especially its feasibility from a metallurgical point of view. Thinks the statements made by the company need careful investigation before meriting the attention of investors. 1800 w. Eng & Min Jour—June 18, 1898. No. 20944.

Colombia.

Gold in the Vicinity of Barbacoas. (L'Or aux Environs de Barbacoas.) Describing the gold washings at Barbacoas, in the State of Cauca, Colombia, at present very imperfectly worked by the natives, but present excellent possibilities. 2500 w. La Revue Technique—June 10, 1898. No. 21023 D.

Colorado.

Colorado Ore Market. From the report of the State mine commissioner. Relating to the methods pursued for the determination of values contained in ores. 1800 w, Min & Sci Press—May 28, 1898. No. 20628.

Crushing.

Sectional Cushioned Rolls. Joseph William Pinder. Describes a system for increasing the efficiency in crushing. Ill. 600 w. Trans of Am Inst of Min Engs—June, 1898. No. 21144 D.

Cyanid Process.

Some Notes on the Recovery of Gold from Cyanid Solutions. S. C. Coles. Read before the Inst. of Min. and Met. Gives results obtained from gold cyanid solutions of varying strengths with aluminum cathodes and iron anodes. 1800 w. Min & Sci Pr—June 11, 1898. No. 20870.

The Stamp Milling of Gold Ore in Its Relation to Cyaniding. E. H. Johnson. A continued discussion of this paper. 6500 w. Jour of Chem & Met Soc of S. Africa—April, 1898. No. 20925 E.

The Cyanid Process as Applied on the Rand. W. Leonard Holms. A fully illustrated account of the working of the low grade ores of the Witwatersrand by the cyanid process, with many practical details. 3500 w. Engineering Magazine—July, 1898. No. 21234 B.

Furnace Construction.

Silver Lead Blast Furnace Construction. H. V. Croll. Notes based on observations of the construction and improvements in the smelting practice of Colorado and Utah, reviewing the progress. 1900 w. Eng & Min Jour—May 28, 1898. No. 20560.

Goldfields.

The Goldfields of British Columbia and the Klondike. William Hamilton Merritt. Deals with the immense possibilities of the mountain ranges of Western British America, giving a very interesting report of the region and the mining operations. Discussion. 8000 w. Jour Soc of Arts—June 10, 1898. No. 20922 A.

Mexican Mines.

Some Mines in Sonora, Mexico. E. T. Dumble. An account of this region, the abandoned properties and working mines, with the opinion that it is destined to become a very active mining region. 1600 w. Eng & Min Jour—June 18, 1898. No. 20945.

New South Wales.

Gold and Tellurides at Cooma, New South Wales. J. E. Carne. A report of this field, furnished to the Department of Mines. 3000 w. Aust Min Stand—May 5, 1898. No. 20720 B.

New Zealand.

The Gold Mines of New Zealand. (Les Mines d'Or de la Nouvelle-Zélande.) A general description, with photographic views, and a geological map of the district of Hauraki. 2000 w. Le Génie Civil—June 11, 1898. No. 21008 D.

Ore Deposits.

Indications of Ore Deposits. E. Lidgey. Some of the indications in various places that lead a prospector to know whether he is on the right track of a lode, reef, or ore deposit. 2000 w. Aust Min Stand—May 5, 1898. Serial. 1st part. No. 20719 B.

Ores.

Ore Occurrence in the Red Mountain District, Colorado. Arthur Lakes. Some of its peculiarities and the causes of them. 2300 w. Mines & Min—June, 1898. No. 20729 C.

Ore Washers.

An Apparatus for the Removal of Sand from the Waste Water of Ore-Washers. J. E. Johnson, Jr. Discussion of this paper, presented at the Atlantic City meeting, Feb., 1898. 900 w. Trans of Am Inst of Min Engs—June, 1898. No. 21143 D.

Peculiar Formation.

A Peculiar Lode Formation. C. E. Willis. Read before the Mining Society of Nova Scotia. Illustrated description of a discovery in Nova Scotia. 700 w. Can Min Rev—May, 1898. No. 20596 B.

Philippines.

Notes on the Philippine Islands. Extracts from a pamphlet by Frank Karuth, entitled "A New Center of Gold Production," describing conditions in the Philippines. 5800 w. Cons Repts, No. 131—June 3, 1898. No. 20634 D.

Rapid Sinking.

Rapid Sinking in a Nova Scotia Gold Mine. A. A. Hayward. Read before the Mining Society of Nova Scotia. Facts from the experience of the writer aiming to show that the best possible results are not being obtained in that community by the methods used. 3500 w. Can Min Rev—May, 1898. No. 20597 B.

Smelting.

Pyritic Smelting and Its Bearing on Certain South African Ores. D. Dörffel. Refers to the two ways of disposing of ores of this character, and some points of importance in pyritic smelting. 2000 w. Jour of Chem & Met Soc of S Africa—April, 1898 No. 20694 E.

Stamp Mills.

Stamp-Mill Indicator Diagrams. Henry Louis. Describes a method, devised by D. B. Morison, of analyzing the action of the ordinary gravity stamp, which has given light on the exact motion of the stamp-head, and promises to be of value in determining the efficiency of a new mill before setting it to its work. 2000 w. Trans of Am Inst of Min Engs—June, 1898. No. 21137 D.

Sulphides.

The Broken Hill Sulphide Problem. Remarks based on information obtained from William Dewar, on the system adopted at Broken Hill, giving a brief account of a plant designed by one of the larger companies. 1700 w. Eng & Min Jour—June 4, 1898. No. 20653.

Veins.

Notes on the Vein-Formation and Mining of Gilpin County, Colorado. Forbes Rickard. Describes the district, the formation, ore deposits, veins, &c. Ill. 4800 w. Trans of Am Inst of Min Engs. June, 1898. No. 21148 D.

IRON AND STEEL.

Basic Steel.

Basic Refined Steel on the Continent. C. E. Stromeyer. Read at the Inst. of Engs. and Shipbuilders in Scotland. Discusses the three processes of basic steel in some detail and aims to show that what the writer calls basic refined steel is a material surpassing that produced in the acid open-hearth. 5800 w. Engng—June 17, 1898. No. 21185 A.

The Rolling of Thomas Steel. (Le Laminage de l'Acier Thomas.) J. Magery. A description of the rolling mills of the basic steel plant at Roth-Erde, near Aix-la-Chapelle. 2500 w. Revue Universelle des Mines—May, 1898. No. 21094 H.

Bertrand-Thiel.

Notes on the Bertrand-Thiel Process. James Hartshorne. Showing the developments of this process and the results. Gives a brief résumé of what has been recently published on this subject. 3800 w. Trans of Am Inst of Min Engs—June, 1898. No. 21138 D.

Blast Furnaces.

Management of Blast Furnaces—Transition from "Rule of Thumb" to Application of Sci-

entific Methods. E. S. Cook. An account of the writer's experience, discussing furnaces, fluxing, fuel, ores, limestone, pig iron, furnace management, modern construction, &c. 10500 w. Sch of Mines Quar—April, 1898. No. 20666 D.

The Heat Balance of the Blast Furnace. (L'Equilibre Calorifique du Haut-Fourneau). G. Rocour. A discussion of the thermal interchanges which take place in the smelting of iron, with examples of the method of computing the thermal efficiency of the blast furnace. 12000 w. 3 plates. Revue Universelle des Mines—April, 1898. No. 21092 H.

By-products.

A By-product of Iron Making. William Gilbert Irwin. Reports the discovery of a method for utilizing iron slag. The product is called carbolite, and from it is produced ethylene gas which is a great improvement over acetylene. 1200 w. Sci Am—June 25, 1898. No. 20994.

Cementation Process.

On the Passage of Carbon into Iron during the Cementation Process. George J. Pitt. Read before the South Staffordshire Inst. of Iron and Steel Works Managers. Gives a detailed account of experimental study which seems to indicate that molecular interchange is the explanation of the mode in which the carbon passes into the iron in this process. 2500 w. Col Guard—June 10, 1898. No. 20963 A.

Chromic Iron.

Chromic Iron in Canada. The facts presented are from a recent report by J. Obalski, inspector of mines for Quebec. Its use in the chemical industries, and facts relating to the deposits. 1600 w. Can Engr—June, 1898. No. 20785.

Hodbarrow Mines.

The Hodbarrow Hematite Iron Ore Mines. Information of these deposits which, until the discovery of the Lake Superior mines, turned out a greater tonnage than any other iron mine in the world. The location of the deposit adds to the difficulties in working. 900 w. Col Guard—June 3, 1898. No. 20838 A.

Iron Trade.

See Economics and Industry, Commerce and Trade.

Malleable Iron.

Malleable Iron in Car Construction. R. M. Galbraith. Showing that economy is secured in its use, but that there is great difference in the quality, and that the design of patterns is important. 1300 w. R R Car Jour—June, 1898. No. 20789.

The Use of Malleable Iron In Car Construction. Drawings and description with tests of a malleable iron bolster. 1000 w. Loc Engng—June, 1898. No. 20692 C.

Mesabi Range.

Sketch of the Geology of the Eastern End of the Mesabi Iron Range in Minnesota. U. S. Grant. Information of the physical features, geology, iron ore, &c. Map. 4200 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20661 E.

Micrography.

The Micro-Structure of Iron and Steel. S. S. Knight. Read at Cincinnati meeting of the Am. Foundrymen's Assn. Showing the benefits to be derived from the use of the microscope in this field. Ill. 5000 w. Am Mfr & Ir Wld—June 17, 1898. No. 20926.

Pig Iron.

Sampling Pig Iron for Analysis. Albert Ladd Colby. A discussion of the methods of sampling pig iron with the object of showing how accuracy can be obtained without unnecessary complications. 5500 w. Ir Age—June 2, 1898. No. 20620.

Slag Bricks.

Slag Bricks in Germany. Information concerning the bricks made from granulated slag, and their superiority to bricks made of fluid slag. 700 w. Cons Repts, No. 144—June 18, 1898. No. 20923 D.

Steel Plant.

The Alabama Steel Plant. A. M. Shook. Relates to the large steel plant to be built by the Tennessee Coal, Iron and Railroad Co; at Ensley, Ala. 1400 w. Ir Age—June 23, 1898. No. 20997.

Steel Testing.

Progress in the Study of Steel. (Les Progrès Realisés dans la Connaissance du Métal Acier.) Ad. Greiner. A discussion of the various methods of testing steel, and giving especial attention to peculiarities of physical constitution as revealed by metallography and microscopy. 5000 w. Revue Universelle des Mines—May, 1898. No. 21093 H.

Steel Works.

See Mechanical Engineering, Shop & Foundry.

Testing.

The Practical Aspect of Present Commercial Methods of Testing Iron and Steel. P. Kreuzpointner. Explains the economic necessities that have made the testing, inspecting and analyzing of materials so important, and discusses the methods used. Discussion. 7800 w. Jour Fr Inst—June, 1898. No. 20669 D.

Tropenas Steel.

Notes on the Tropenas Steel Process. Alexander Tropenas. Read at the Cincinnati meeting of the Am. Foundrymen's Assn. Gives description of plant operation, quality of metal, &c., with cost. 4000 w. Ir Age—June 16, 1898. No. 20860.

MINING.

Accident.

Report on the Snaefell Lead Mine Accident. Abstract of report of C. Le Neve Foster on the circumstances attending the underground fire at the Snaefell lead mine in the month of May, 1897. 7000 w. Col Guard—June 3, 1898. No. 20837 A.

Blasting.

The Permitted Safety Gunpowder Cartridge for Coal Mines. Donald M. Stuart. Résumé

of a paper on th's subject, at meeting of Colliery Managers' Assn., England. It describes the conditions required in a safe explosion, and claims this cartridge meets the requirements, reporting trials, &c. 900 w. Col Guard—June 17, 1898. No. 21179 A.

Boring.

Boring in Mines. T. Railton. Notes of a lecture delivered to mining students at Abercynon. Results from the experience of the writer, dealing with methods and different classes of work in boring. 2500 w. Col Guard—May 20, 1898. No. 20588 A.

Drilling.

Mechanical Rock-Drilling in Mines. M. J. Kersten. Describes various types of rock-drills, and methods of working them. Ill. 2700 w. Col Guard—June 3, 1898. No. 20836 A.

Dynamite.

Some Notes on the Mechanical Tests, Uses, Effects and History of Dynamite. Arthur Edwin Haynes. An interesting discussion of this powerful agent and the uses made of it. 3000 w. Year Bk of Soc of Engs, Univ of Minn—1898. No. 20659 E,

Explosion.

A Dust Explosion. David Griffiths. A peculiar explosion on a tipple at the Crested Butte Mine, Colorado. 900 w. Mines & Min—June, 1898. No. 20726 C.

Explosives.

Experiments with Safety Explosives. From *Mining Engineering*. The results of some of the latest German experiments and deductions therefrom. 1500 w. Mines & Min—June, 1898. No. 20725 C.

On the Various Systems of High Explosives and the Conditions of Their Economical Application to the Different Methods of Coal-Working in British Collieries. John Heath. Special prize essay. An account of experiments is given in part first. 3000 w. Ir & Coal Trds Rev—June 3, 1898. Serial. 1st part. No. 20839 A.

Firedamp.

Ignition of Firedamp and Coaldust by Electricity. Heise and Theim in *Zeit für Angewandte Chemie* Detailed conclusions deduced from experiments made by the writers. 700 w. Col Guard—June 10, 1898. No. 20961 A.

Haulage.

An Overland Cable Haulage Installation at the Monceau-Fontaine Collieries. Translated from the *Annales des Mines de Belgique*. Describes the Dinnendahl system of haulage, giving cost of installation. Ill 500 w. Ir & Coal Trds Rev—June 3, 1898. No. 20840 A.

Hoisting Plant.

Arrangement of a Mine Hoisting Plant. (Zusammensteilung der bei Anlage von Streckenförderanlagen zu Berücksichtigenden Punkte.) A very full discussion of the most economical arrangement for certain given conditions, including the use of an electric motor winding engine. 5000 w. 2 plates. Glückauf—May 21, 1898. No. 21099 B.

Mine Air.

Mine Air Analysis and Firedamp Detection. M. S. Chesneau. From a communication to the International Congress of Applied Chemistry. Shows the importance of analyzing the air of mines, and discusses the methods used in France for the determination of firedamp. 3000 w. Col Guard—May 20, 1898. No. 20585 A.

Mine Ventilation.

Theory of the Equivalent Orifice. M. Lafitte. From a communication to the Société de l'Industrie Minérale, Sainte Etienne. An adaptation of Guibal's theory of moduli to the notion of the equivalent orifice due to M. Murque, and generally adopted on account of the convenient representation it affords of a mine's resistance. 1200 w. Col Guard—June 17, 1898. No. 21180 A.

Mining Industry.

The Mining Industry, and the Relation of the Federal Government to it Through the Work of the Different Departments. E. W. Parker. Considers briefly the different bureaus each of which deals with mining matters from a different standpoint. 3000 w. Mines & Min—June, 1898. No. 20728 C.

Ore Reserves.

Calculating Value of Ore Reserves. John Clince Little. Abstract of paper in the *Journal of the British Association of Mining Students*. Gives a diagram for estimating ore in sight, and offers suggestions for the speedy manipulation of figures that may result from careful measuring and sampling. 1700 w. Eng & Min Jour—June 25, 1898. No. 21171.

Pit Props.

The Strength of Pit Props. H. Louis. Abstract of paper read before the Fed. Inst. of Min. Engs., England. Researches confined to the initial strength of the prop when ready for setting. Gives results of experiments. 2800 w. Ir & Coal Trds Rev—May 27, 1898. No. 20698 A.

Progress.

Twenty Years' Mining Progress. James T. Forgie. Abstract of a presidential address delivered before the Mining Inst. of Scotland. Reviews the marked progress in Great Britain and especially in Scotland. 3200 w. Col Guard—June 17, 1898. No. 21181 A.

Reports.

Reports of the Inspectors of Mines for 1897. Gives reports of the Liverpool district, Durham district, and Newcastle district 1500 w. Col Guard—May 20, 1898. No. 20586 A.

Safety Lamp.

Firedamp-Indicating Lamp. M. G. Chesneau. From a communication to the Second International Congress of Applied Chemistry. Particulars of this appliance based on the results of active practice, as more than 400 are in service. Ill. 3500 w. Col. Guard—May 27, 1898. No. 20714 A.

Shafts.

Sinking and Equipping Deep Winding Shafts.

E. Tomson. From a communication to the jubilee meeting of the Liege Engineers' Assn. Gives results of the writer's studies for laying out of Preussen No. 1 for depth of working from 400 m. to 800 m., and Preussen No. 2, for 450 m. to 1000 m. Ill. 3900 w. Col Guard —June 10, 1898. No. 20959 A.

Sinking the Maypole Shafts Near Wigan. James Keen. Abstract of a lecture delivered at the Wigan Mining School. An interesting description of the work as far as it has progressed. 4000 w. Col Guard—May 20, 1898. No. 20584 A.

Surveying.

A Contribution to Mine Surveying. Bergrath Brathuhn in *Berg- und Hüttenmännische Zeitung*. Explains the determining the depth of perpendicular shafts by the aid of a measuring wheel, determining the perpendicular by the aid of an inscribing plummet, and other measurements. 2200 w. Col Guard—May 20, 1898. No. 20587 A.

Winding.

Improvements in Winding Appliances. E. M. Hann. Read before the South Wales Inst. of Engs. Illustrated description of some practical improvements made in existing plants, with some suggestions for further improvements. 2200 w. Col. Guard—June 17, 1898. No. 21177 A.

MISCELLANY.

Alloys.

Mechanical Properties of Certain Aluminum Alloys. R. C. Carpenter. Facts that have been definitely determined during investigations carried on at the laboratories of Sibley College, Cornell University. 3700 w. Am Soc of Mech Engs, No. 784—June, 1898. No. 20755 D.

The Constitution of Ternary Alloys. (Sur la Constitution des Alliages Ternaires.) Georges Charpy. A micrographic examination of alloys of lead, tin, and bismuth, showing how the different constituents are arranged in the alloy. 1500 w. Comptes Rendus—June 6, 1898. No. 21033 D.

Asbestos.

Asbestos. Paul Kersting. Communication from the Laboratory of the Royal Technical High School, at Berlin. The properties of this substance, where principally found, the varieties, with analyses. 1800 w. Am Mfr & Ir Wld—June 3, 1898. No. 20695.

Caucasus.

Notes on the Geological Structure of the Caucasus Range Along the Georgia Military Road. Dr. Persifor Frazer. Notes on the formation, based mainly on the labors of the Russian Geological Survey. 1300 w. Trans of Am Inst of Min Engs—June, 1898. No. 21141 D.

Fluorine.

The Fluorine Mine. Arthur Lakes. An illustrated description of a geological puzzle furnished by the formations on Copper mountain near Cripple Creek. Discusses the practical bearing of the solution of such questions upon mining development, and how a correct solution prevents needless waste of time and money. 3300 w. Mines & Min—June, 1898. No. 20724 C.

High Temperatures.

Aluminum for High Temperatures and for the Reduction of Metals from their Oxides. J. B. Nau. Describes the method of Hans Goldschmidt for the extraction of metals from their oxides by means of metallic aluminum. 2000 w. Ir Age—June 16, 1898. No. 20855.

A New Method of Generating High Temperatures. (Ueber ein Neues Verfahren zur Erzeugung Hoher Temperaturen.) Dr. H. Goldschmidt. The process is based on the fact the aluminum develops a high temperature in entering into combination, and hence raises the temperature when used as a reducing agent. 3000 w. Stahl und Eisen—May 15, 1898. No. 21072 D.

Joplin, Mo.

Lead and Zinc Milling and Concentrating in the Joplin, Mo., District. E. Hedburg. The primitive mode procedure and the latest modern plants, showing the different systems in use in its several stages for the different classes of ores. Ill. 2000 w. Mines & Min—June, 1898. No. 20721 C.

Manganese.

The Manganese-Ore Industry of the Caucasus. Frank Drake. Mainly descriptive of the manganese district of Chiaturi, the location and topography, the deposits and their characteristics, methods and cost of mining, etc. Ill. 3600 w. Trans of Am Inst of Min Engs—June, 1898. No. 21146 D.

Metal Working.

Limitations of Milling in Metal Working. John Richards. Tracing some of the conditions and limitations, as far as proved by common practice. 1200 w. Am Mach—June 16, 1898. No. 20862.

Mica.

Mica Mining in the District of Nellore, India. Robert W. Thompson. Describes the region, the deposit, and matters relating to the industry. As the deposit is near the surface the method of working is mere quarrying. The cutting and sorting is of great importance. 2000 w. Jour Soc of Arts—June 17, 1898. No. 21191 A.

Minerals.

United States Mineral Production in 1897. Statistics of the production of minerals and metals in the United States, as arranged for "The Mineral Industry." 4500 w. Eng & Min Jour—May 28, 1898. No. 20559.

New Caledonia.

Mineral Resources of New Caledonia. Henry W. Edwards. An account of the geology and minerals of this island of the South Pacific, with report of conditions of labor, mining operations and processes used in the treatment of the ores. Ill. 3000 w. Eng & Min Jour—May 28, 1898. No. 20561.

Newfoundland.

Mining in Newfoundland. James P. How-

ley. A letter containing statistics of the mineral development, and giving an account of the progress and present standing of this industry. 1200 w. Can Min Rev—May, 1898. No. 20593 B.

Nickel.

The Occurrence and Production of Nickel. Perry F. Nursey. Particulars respecting the occurrence and production in the United States. 2500 w. Ind & Ir—June 10, 1898. No. 20953 A.

Nickel Alloys.

The Microstructure of Alloys of Iron and Nickel. (Sur la Microstructure des Alliages de Fer et de Nickel.) A preliminary note by M. Osmond, giving the micrographic classification of the nickel-iron alloys up to 50 per cent. of nickel. 1000 w. Comptes Rendus—May 9, 1898. No. 21027 D.

Oil Field.

The Recently Developed Oil Field of Texas. Thomas D. Miller. Paper presented to the Engs' Club of St. Louis. All the petroleum in Texas yet examined has an asphaltum base. An account of the oil-producing field, the production and quality. 1000 w. Eng & Min Jour—June 18, 1898. No. 20948.

Petroleum.

The Manufacture of Illuminating Oil at Baku in 1897. W. Latkin. Report of the production, methods used, quality, etc. 1400 w. Am Mfr & Ir Wld—June 24, 1898. No. 21220.

Reconnaissance.

Notes of a Reconnaissance from Springfield, Mo., into Arkansas. E. J. Schmitz. An inspection of the zinc, lead, and other resources of this region, and a rapid view of the topography. 2300 w. Trans of Am Inst of Min Engs—June, 1898. No. 21145 D.

Respirator.

Comparative Tests of the Neupert Respirator and the Walcher-Gärtner Pneumatophor. (Versuche mit O. Neupert's Rettungsapparat, nebst einem Vergleichenden Versuch mit dem Walcher-Gärtner'schen Pneumatophor.) R. Heller. The tests were made for periods of two hours at a time, and demonstrated that the oxygen in the air could be replaced, and the carbonic acid removed satisfactorily. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 21, 1898. No. 21098 B.

Russia.

Geological Excursion Through Southern Russia. S. F. Emmons. Presents some features of the trip of interest to the mining engineer and geologist. Ill. 7400 w. Trans of Am Inst of Min Engs—June, 1898. No. 21135 D.

Smelting.

Electric Smelting. W. S. Horry. Abstract of paper read before the Northwestern Electrical Assn. giving investigations made with electric smelting, and stating that there is every reason to expect great things from this method. 1300 w. Elec Wld—June 25, 1898. No. 21109.

The Possibilities for Smelting in British Columbia. R. A. Hedley. Read before the Fed. Can. Min. Inst. Information concerning the character of the ores and cost of smelting. 1400 w. Can Engr—June, 1898. No. 20787.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene Generators. Dr. N. Caro. Abstract translation of article in the *Zeitschrift für Beleuchtungswesen*. Considers the reactions by which acetylene is produced, the necessity of a gasholder, and how the generators devised for use stand with regard to the existing conditions. 2800 w. Jour Gas Lgt—June 14, 1898. No. 21104 A.

Apparatus for the Production of Acetylene Gas. Illustrates and describes the "Revolver" apparatus of the Société du Gaz Acetylene, and its operation, and the Reibel apparatus. Particulars and illustrations taken from *Le Genie Civil*. 2200 w. Sci Am Sup—June 18, 1898. No. 20866.

Professor Lewes on Acetylene Generators. Abstract of paper read at meeting of the London Section of the Society of Chemical Industry. Notes the especially dangerous impurities; discusses the existing types of generators; describing experiments made. 1400 w. Jour Gas Lgt—June 14, 1898. No. 21103 A.

The Acetylene Gas Exhibition. Perry F. Nursey. An account of the exhibition of acetylene gas apparatus and production in London. 6500 w. Ind & Ir—June 17, 1898. No. 21189 A.

The Purification of Acetylene. Shows the need of purification and briefly explains Dr. Wolff's scheme which is considered practical and efficient. 900 w. Jour Gas Lgt—June 14, 1898. No. 21101 A.

Address.

Presidential Address before the Institution of Gas Engineers, England. G. E. Stevenson. Reviews the events which have affected the gas industry of England during the last year, discusses the inclined-retort system, carbonizing plant, carburetted water-gas, &c. 5500 w. Jour of Gas Lgt—June 14, 1898. No. 20999 A.

Bench Firing.

Isolated Generators for Bench Firing. Extracts from letters of English gas engineers on this subject, with comments and discussion. 4300 w. Am Gas Lgt Jour—June 20, 1898. No. 20931.

Carbonizing.

A new Departure in Carbonizing, Having for its Objects the Prevention of Naphthalene Troubles and the Providing of Cheap Enrichment. S. and T. Glover. Read at meeting of Inc. Inst. of Gas Engs. Gives an account of the process adopted and measure of success attained. Discussion. 9500 w. Gas Wld—June 18, 1898. No. 21198 A.

The Carbonizing Plant of a Modern Gas-

Works. F. D. Marshall. Read at meeting of Inc. Inst. of Gas Engs. Describes the carbonizing plant of the Frederiksberg works of the Danish Gas Co., giving costs, working results, &c. Discussion. Ill. 10000 w. Gas Wld—June 18, 1898. No. 21195 A.

Convention.

Convention of the Technical Society of the Gas Industry in France. (Société Technique de l'Industrie du Gaz en France. Congrès de Nice.) A general report, with abstracts of the papers presented. 3000 w. Le Génie Civil—May 21, 28, 1898. Two articles. No. 21003 each D.

Decomposition.

The Decomposition of Gas Oil, Phenol, and Creosote by Heat. A summary of researches carried out by Dr. E. Müller at the Chemical Technical Inst. at Carlsruhe. Abstract translation from the *Journal für Gasbeleuchtung*. 2500 w. Jour Gas Lgt—June 7, 1898. Serial. 1st part. No. 20884 A.

Distribution.

High-Pressure System of Distribution. Fletcher W. Stevenson. Read at meeting of Inc. Inst. of Gas Engs. Describes this system as used at Sheffield, Eng. Discussion. 4800 w. Gas Wld—June 18, 1898. No. 21193 A.

Enrichment.

Enrichment of Coal Gas. George H. Harper. Read at Detroit meeting of the Western Gas Assn. A summary of what is known concerning this question, discussing the methods in general use. Followed by a contribution to the discussion by W. W. Goodwin, entitled "Enrichment of Coal Gas by Acetylene," and a general discussion. 11000 w. Pro Age—June 1, 1898. No. 20621.

Gas Analysis.

The Simple and Efficient Gas Analysis Apparatus. Dr. W. H. Birchmore. Describes and illustrates a simple and efficient apparatus, explaining the method of using. 1400 w. Am Gas Lgt Jour—June 27, 1898. No. 21218.

Gas Apparatus.

Washers and Scrubbers. Edward A. Harmon. Reviews the conditions under which gas is liberated and discusses the functions of washers and scrubbers, the object and the methods. Describes the various forms of apparatus. 10500 w. Gas Wld—June 18, 1898. No. 21199 A.

Gasholder.

The Three-Lift Gasholder at Sutton. F. S. Cripps. Illustrated description with remarks on the construction. 1700 w. Jour Gas Lgt—May 24, 1898. No. 20599 A.

Gas Liquors.

Methods of Estimating the Value of Gas Liquors. O. O. Thwing. Read at Detroit meeting of the Western Gas Assn. Deals with the volumetric test of ammoniacal liquors. Discussion. 5500 w. Pro Age—June 15, 1898. No. 20810.

Gas Prospects.

The Present and Future Prospects of Gas for Lighting, Heating and Power Purposes. Henry R. Lordly. Discusses the impetus given the industry by the invention of the Welsbach burner, and other appliances for lighting, heating and motive power. Ill. 6500 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21129 D.

Gas Works.

Halifax Corporation Gas Works. Illustrated description of a new purifying house. 800 w. Engr, Lond—June 10, 1898. No. 20966 A.

Inflammability.

The Limits of Inflammability of Carbon Monoxide and Other Combustible Gases. H. Le Chatelier and Boudouard. Gives the results of investigations and calculations. 700 w. Col Guard—June 10, 1898. No. 20960 A.

London Gas.

The Gas Industry. Some interesting items relating to the manufacture of gas in London, taken from the last annual report. 1500 w. Builder—June 4, 1898. No. 20820 A.

Machinery.

Gas-Works Machinery. Edward A. Harmon. Read at meeting of London Soc of Engs. Remarks on the special requirements for machinery in gas works, to meet the conditions, with a review of many of the mechanical appliances. 7500 w. Jour Gas Lgt—June 7. 1898. No. 20883 A.

Gas-Works Machinery. Discussion on paper by E. A. Harmon. 4500 w. Jour Gas Lgt—June 14, 1898. No. 21105 A.

Measurement.

Report upon the Temperature of Gas Measurement. Report, tables and diagrams of the sub-committee appointed by the Institution of Gas Engineers (London). 800 w. Gas Wld—June 4, 1898. No. 20822 A.

Standards of Light and Temperature of Gas Measurement. Discussion at meeting of the Incorporated Institution of Gas Engineers, England. 2300 w. Gas Wld—June 18, 1898. No. 21192 A.

Meters.

The Prepayment Meter. C. H. Raynor. Read at Detroit meeting of the Western Gas Assn. Reports the experiences of various companies using these meters, and the advantages of their use. Discussion. 7000 w. Pro Age—June 1, 1898. No. 20623.

Natural Gas.

The Discovery of Natural Gas in Sussex, England. An outline of investigations of C. Dawson and Dr. Hewett in regard to the utility of this gas, with an account of its discovery, and probable origin. 1800 w. Jour of Gas Lgt—June 14, 1898. No. 21100 A.

Ownership.

The Relation of the Gas Supply to the Public. John H. Gray. Reviews the history of the gas industry and considers that the only road to reform lies through legislation, by which the accounts and books of the companies shall be kept in a uniform manner and then given to the state and ultimately to the public. 4200 w. Munic Af—June, 1898. No. 20918 C.

Photometry.

Photometric Standards. W. Grafton. Gives experimental results in the hope of clearing up existing difficulties. Explains in part first what is meant by a standard light of a candle, and gives tests of candles to ascertain normal light. 2200 w. Jour Gas Lgt—June 14, 1898. Serial. 1st part. No. 21102 A.

Pintsch Gas.

The Pintsch Gas System of To-day. F. H. Shelton. Describes the Pintsch gas producing plant at Washington, D. C., as typical of the large number extending from the Atlantic to the Pacific, and gives interesting facts in connection with its extensive use in railway lighting. 2500 w. Am Gas Lgt Jour—May 30, 1898. No. 20558.

Purification.

Complete and Continuous Purification of Coal Gas in Closed Vessels Without Nuisance. Ernest J. Sutcliffe. Describes a method believed to be both feasible and practicable. The plan is a combination of the system of milk or cream of lime purification, and of the Claus sulphur recovery process. 2700 w. Jour Gas Lgt—May 31, 1898. No. 20737 A.

Retorts.

Hindrance to the Adoption of the Inclined Retort in America. Frederick Equer. Read at Detroit meeting of the Western Gas Assn. Presents the advantages and economy to be gained. Discussion. 3500 w. Pro Age—June 15, 1898. No. 20811.

The Construction and Working of Inclined Retorts. E. Drory. Read at meeting of Inc. Inst. of Gas Engs. The writer's experience of nine years, dealing with the construction and working of inclined retorts. 2800 w. Gas Wld—June 18, 1898. No. 21194 A.

Self-Lighters.

Recent Progress in Self Lighters for Incandescent Lamps. M. Syssoyeff. Abstract of a paper read before the "Société Technique de l'Industrie du Gaz en France." Reviews the attempts that have been made to solve this problem and reports highly satisfactory results obtained in lighting gas by chemical reaction. 2000 w. Pro Age—June 15, 1898. No. 20812.

Standard Lamp.

A Two-Candle Pentane Standard. E. Llewellyn Pryce. Read at meeting of Inc. Inst. of Gas Engs. Describes the Simmance 2 candle standard, which is a modification of Harcourt's portable pentane lamp. Discussion. 9300 w. Gas Wld—June 18, 1898. No. 21197 A.

The Pentane Ten-Candle Standard Lamp. A. Vernon Harcourt. Read at meeting of the Inc. Inst. of Gas Engs. An account of this lamp and the improvement made, manner of adjusting, etc. 2300 w. Gas Wld—June 18, 1898. No. 21196 A.

Testing.

The Revised Instructions of the Metropolitan Gas Referees. The portions in which changes have been made in the new instructions in regard to the testing of gas which have been prepared by the Metropolitan Gas Referees, London. 8000 w. Jour Gas Lgt—May 31, 1898. No. 20738 A.

Texas.

Recent Developments in Texas. Thomas D. Miller. Gives a brief historical sketch of the gas industry in the state, the coals used, &c. Discussion. 2800 w. Pro Age—June 1, 1898. No. 20624.

Use of Gas.

The Use of Gas for Purposes Other Than Lighting. C. W. Blodget. Read at Detroit meeting of the Western Gas Assn. Showing the desirability and almost the necessity of securing other uses for gas than lighting, and the means of advancing this industry. Discussion. 5800 w. Pro Age—June 1, 1898. No. 20622.

SEWERAGE.

Damages.

Damages Due to Sewage Disposal. Reviews a recent decision by the State Supreme Court of New York. 1500 w. Eng Rec—June 4, 1898. No. 20641.

Filtration.

Sewage Filtration at Winsford. Describes a system of filtration which has been in use for nearly twenty years with marked success, and the conditions which have made the cost of operation small. 3300 w. Engr, Lond—June 17, 1898. No. 21186 A.

Oyster Beds.

Oysters and Sewage. Describes conditions causing enteric fever in Brightlingsea, England. 600 w. Eng Rec—May 28, 1898. No. 20535.

Pollution.

An Injunction Against Sewage Pollution of a California Stream. Review of an important decision of the Supreme Court. 900 w. Eng Rec—June 25, 1898. No. 21158.

Sewage.

The Sewerage of Paris, France. James H. Fuertes. Illustrated explanation of features previously undescribed. 1200 w. Eng Rec—June 11, 1898. Serial. 1st part. No. 20805.

Sewage Disposal.

Report on the Precipitation System of Sewage Disposal in Operation at Hamilton, Ont. W. M. Watson. Details and account of expenses, showing that the system is very costly. 2500 w. Can Engr—June, 1898. No. 20786.

Sewage Disposal. Benjamin F. La Rue. From *Home Study Magazine*. Introductory remarks with brief notice of the methods of natural disposal, clarification and application to the soil. 2500 w. Sci Am Sup—June 11, 1898. No. 20746.

The Dilution Process of Sewage Disposal. Rudolph Hering. An examination of the conditions under which sewage may be made harmless as a waste discharge by dilution in public water courses and other bodies of water. 3500 w. Engineering Magazine—July, 1898. No. 21233 B.

STREETS AND PAVEMENTS.

Asphalt.

Laboratory Tests of Asphalt. A. W. Dow.

Gives a copy of the report of S. P. Sadtler to the city clerk of Los Angeles, Cal., with criticisms of the conclusions drawn from the results obtained. 2800 w. Munic Engng—June, 1898. No. 20550 C.

Brick Testing.

Standard Methods of Testing Paving Brick. Arthur N. Talbot. Describes a series of tests made in the Laboratory of Applied Mechanics, Univ. of Illinois, which show that the standard method of the Nat. Brick Mfrs. Assn. should not be adopted without further investigation. 2000 w. Technograph, No. 12—1897-8. No. 20908 D.

Testing Paving Brick. Describes recent tests indicating defects in National Brick Manufacturers' Assn. specifications. 900 w. Eng Rec—June 18, 1898. No. 20932.

Pavements.

A Decision as to Front-Foot Assessments. A review of a decision by the Wisconsin Supreme Court as to the legal forms which must be followed to make such assessments binding. 900 w. Eng Rec—May 28, 1898. No. 20533.

Cement Grout for Pavements. Report of tests at Albany to determine best way of making grout. 800 w. Eng Rec—May 28, 1898. No. 20542.

Stone Block Street Pavements. Charles Carroll Brown. The importance of a good foundation, and care in selecting blocks of uniform size. While the first cost is high, the pavement is almost indestructible. 800 w. Stone—June, 1898. No. 21216 C.

WATER SUPPLY.

Analyses.

Interpretation of Water Analyses. Floyd Davis. Abstract of a paper read before the Iowa Engineering Soc. Reviews the methods used in investigating water supply, giving much information of evidences of contamination. 4800 w. Munic Engng—June, 1898. No. 20551 C.

Birmingham.

The Water Supply of Birmingham. (L'Alimentation d'Eau de Birmingham.) A description from English sources, with photographic illustration of pumping engines. 1800 w. La Revue Technique—May 25, 1898. No. 21016 D.

Cardiff.

Extension of Filter-Beds, &c., Service Reservoirs, and Water Tower, Cardiff. C. H. Priestley. Abstract of paper and discussion at meeting of British Assn. of Water-Works Engs. Description of improvements. 4800 w. Jour Gas Lgt—June 7, 1898. No. 20885 A.

Contracts.

Municipal Franchise Contracts. H. E. Keeler. Read before the Am. Water Works Assn. Discusses the proper relations of municipalities and private water companies. 2800 w. Eng Rec—June 25, 1898. No. 21161.

Compressed Air.

Compressed Air for Water Works. Oscar Darling. Illustrated description of the application of compressed air to the operation of water-supply systems, with a statement of the advantages claimed. 800 w. Fire & Water—June 11, 1898. No. 20809.

Croton Dam.

The New Croton Dam. Illustrated description of the design and construction to date of this remarkable structure. 5300 w. Eng Rec—June 11, 1898. No. 20803.

Discharge.

Description of the Method of Gauging the Discharge Through the Outlet of Hemlock Lake, N. Y. John F. Skinner. Describes the method used to ascertain the discharge of Hemlock Lake, the source of the water supply of Rochester, N. Y., through its outlet. 1800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21133 D.

Fermentation.

Ridgewood Reservoir Diatoms. Samuel McElroy. A statement of the conditions and an explanation of the cause of the trouble. 1300 w. Fire & Water—June 11, 1898. No. 20808.

Filtration.

Filtration at Reading. Gives an account of the sources of the supply, and the steps being taken to provide a filtration plant. 1400 w. Fire & Water—May 28, 1898. No. 20556.

My Experience in Filtration and Aeration. S. A. Charles. The writer's experience at Lexington, Ky., greatly favors the use of mechanical filters, with aeration. 1800 w. Fire & Water—June 18, 1898. No. 20943.

The Benefit of Water Filtration—Illustrative Examples. John W. Hill. Abstract of address before the Arapahoe and Denver Medical Society. Explains the method which nearly fifty years of use in Europe has proved to be practical and efficient. 1500 w. San—June, 1898. No. 20672 D.

The Efficiency of the London Filters. Summary of official data indicating a bacterial purification of over 99 per cent. in every case. 800 w. Eng Rec—May 28, 1898. No. 20540.

The Little Falls Sand Filter. Illustrated description of a one-acre open sand filter costing but $11,750. 1200 w. Eng Rec—June 4, 1898. No. 20646.

The Operation of a Slow Sand Filter. Charles E. Fowler. Experiences and facts in regard to the first sand filter in America, located at Poughkeepsie, N. Y., to render the water of the Hudson fit for domestic use. Discussion. 15000 w. Jour of New Eng Water Works Assn—June, 1898. No. 20904 F.

The Water-Works and Filter Plant of Ripley, N. Y. E. A. Wilder. Describes the locality and conditions which were unusual, but successfully overcome by the use of a shield. Also describes the filter which had a capacity of 200,000 gallons per day. Ill. 2800 w. Eng News—June 9, 1898. No. 20771.

Flow.

Flow of Water. W. J. Millar. Discusses the three principal causes of loss of head. 700 w. Ind Engng—May 7, 1898. No. 20777 D.

Gas Engines.

Gas and Gasoline Engines as Applied to Small

Water-Works Plants. Charles O. Rogers. Paper read at meeting of Engs' Soc. of W. Penna., Pittsburg. Gives an account of various pumping plants where gas engines were installed, with tests made. 3000 w. Am Mfr & Ir Wld—May 27, 1898. No. 20554.

Inspection.

Cast-Iron Pipe Inspection. T. W. Yardley. Abstract of paper presented at meeting of Am. Water-Works Assn. Gives methods and requirements of inspection. 900 w. Eng Rec—June 18, 1898. No. 20937.

Leakage.

Loss of Water from Pipes. F. H. Crandall. A report on the Burlington (Vt.) High Service, which is free from many of the difficulties ordinarily encountered in solving this question. Discussion. 3000 w. Jour of New Eng Water Works Assn—June, 1898. No. 20905 F.

Manchester, Eng.

The Water Supply of Manchester, England. James H. Fuertes. Brief description of old and new works. 700 w. Eng Rec—June 4, 1898. No. 20648.

Mill Rights.

Compensation Water for Mills. Stephen E. Babcock. Paper, slightly condensed, read before the Am. Water-Works Assn. Describes the method adopted at Little Falls, N. Y., to avoid damages for injured water rights. 3000 w. Eng Rec—June 25, 1898. No. 21162.

Munich, Germany.

The Water-Works of Munich, Germany. James H. Fuertes. Illustrates a plant for intercepting about 50,000,000 gallons of ground water daily. 900 w. Eng Rec—June 25, 1898. No. 21163.

Olean Well.

The Story of a Well. A review of the legal difficulties caused by faulty specifications for a well. 1200 w. Eng Rec—June 11, 1898. No. 20802.

Pipe Test.

Test of Concrete Iron Pipe. Ernest L. Ransome. Describes test by hydraulic pressure of a pipe 7 feet in diameter. 600 w. Eng Rec—May 28, 1898. No. 20546.

Private Baths.

Free Water for Private Baths. L. N. Case. Extract from a paper presented at the recent convention of the Am. Water-Works Assn., condemning the project. 1000 w. Eng Rec—June 18, 1898. No. 20936.

Private Plant.

Water Supply and Sewerage of the Kunhardt Estate. Illustrated description of a complicated system for a large country place. 1500 w. Eng Rec—June 15, 1898. No. 20935.

Pumping Plant.

The Efficiency of Air Lift Apparatus. Herbert T. Abrams. A letter claiming 45 per cent. for a well designed plant. 700 w. Eng Rec—May 28, 1898. No. 20547.

Reservoirs.

An Artificial Ground Water Reservoir. Describes a sunken masonry dam storing 5,700,000 cu. ft. in a gravel bed. 700 w. Eng Rec—May 28, 1898. No. 20541.

Covering a Storage Reservoir at Quincy, Ill. Dow R. Gwinn. Describes the construction of roof of white pine, built to lessen the trouble from vegetable growths. Ill. 1500 w. Eng News—June 9, 1898. No. 20776.

The Quincy, Ill., Settling Reservoir. Dow R. Gwinn. Illustrated description of a covered masonry basin with electric water-level annunciator. 1000 w. Eng Rec—June 4, 1898. No. 20647.

The Water Supply of St. Etienne, France. James H. Fuertes. Describes two remarkable reservoirs. 800 w. Eng Rec—May 28, 1898. No. 20539.

Rochester, N. Y.

A Few Considerations of Municipal Water Supply, with Special Reference to That of Rochester, N. Y. E. Kuichling. Briefly notices a few of the problems of water supply engineering, discusses the quality and quantity of the Rochester supply, and gives the general design and construction of the works. Ill. 4400 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21121 D.

St. Joseph, Mo.

St. Joseph's Valuable Water Plant. An account of the plant and the expensive additions made. New pumps, new filtering plant, many miles of new mains, etc. 1200 w. Fire & Water—May 28, 1898. No. 20555.

Steel Pipe.

A Rivetless Longitudinal Joint for Steel Pipe. Adelaide Water Works, South Australia. Alex. B. Moncrieff. Describes a new design of pipe considered in every respect an advance. 400 w. Eng News—June 9, 1898. No. 20775.

Submerged Mains.

Laying a 24-inch Main Under the Nashua River. Horace G. Holden. Describes the work of connecting the water mains by a loop that would supply the portion of the city of Nashua on the opposite side of the river, in case any accident occurred to the bridge that has for forty-four years held the suspended pipes. Discussion. 3000 w. Jour of New Eng Water Works Assn. June, 1898. No. 20906 F.

Town Supplies.

The Sources of Town Water Supplies, and Their Bearing Upon the Public Health. R. E. W. Berrington. Abstract of paper and discussion before the British Assn. of Water Works Engs. Briefly notes the usual sources of supply, the need of being watchful of their purity, and of furnishing a plentiful supply. 3000 w. Jour Gas Lgt—June 14, 1898. No. 21106 A.

Water Project.

The Revival of the Ramapo Water Project. A review of various attempts to obtain private contracts to supply New York. 1200 w. Eng Rec—June 25, 1898. No. 21159.

Water Ram.

Unsteady Flow of Water in Pipes—Water Ram. Irving P. Church. A brief re-statement of the theory presented in a former article,

with an account of the work of B. F. Latting in this field, and later theoretical developments by the writer. Ill. 3800 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21123 D.

Water Tank.

The Elevated Water Tank of the Iowa State Agricultural College. A. Marston. A design of the writer, including some novel features. Ill. 1800 w. Eng News—June 9, 1898. No. 20774.

Water Works.

Bay City Water Works. E. L. Dunbar. An interesting account of the construction of the works and the improvements made. 1700 w. Fire & Water—June 18, 1898. No. 20942.

Wyoming, Ohio.

Free Water and Meterage in Wyoming, Ohio. Discusses the present system and its defects, the objections to the meterage of water, and the finances. 800 w. Fire & Water—June 4, 1898. No. 20696.

MISCELLANY.

Address.

Presidential Address at the Third Annual Meeting of the Municipal Electrical Association, London. A. H. Gibbings. Deals principally with matters of interest to the association. 3800 w. Elec Eng, Lond—June 10, 1898. No. 20973 A.

Living Conditions.

The City's Health-Living Conditions. Dr. A. S. Daniel. An interesting paper on the life and work of the very poor, mostly foreigners, in New York City. 5500 w, Munic Af—June, 1898. No. 20920 C.

Management.

Management of Electrical Undertakings by Local Authorities. Councillor Hesford. Read at meeting of the Munic. Elec. Assn., London, with discussion. 2500 w. Elec Eng, Lond—June 10, 1898. No. 20974 A.

Ownership.

Municipal Ownership. Roderick J. Parke. Presents the principal considerations for and against, and the control of municipal industrial services, especially the supplying of electrical current for street lighting, &c. Aims to present facts which must be considered before a wise conclusion can be reached. 2500 w. Can Eng—June, 1898. Serial. 1st part. No. 20783.

Refuse.

The Disposal of Household Refuse in New York. (L'Enlevement et le Traitement des Ordures Ménagères à New York.) An illustrated description of the methods for handling garbage and light refuse, compiled from American sources. 2000 w. La Revue Technique—June 10, 1898. No. 21020 D.

Sanitation.

The City's Health-Sanitary Construction. Charles F. Wingate. Describing the changes which have taken place in New York city in recent years, showing the progress and the needed reforms. 4000 w. Munic Af—June, 1898. No. 20921 C.

Wastes.

The Present European Practice in the Disposal of the Wastes of Large Cities. James H. Fuertes. Deals with the receptacles, collection and disposal of refuse as carried out in various places. Ill. 5000 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21122 D.

Working Conditions.

The City's Health-Working Conditions. Henry White. A discussion of how the government of the city may improve the working conditions. Considers sweating, factory inspection, rents, &c. 4400 w. Munic Af—June, 1898. No. 20919 C.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in May. Detailed list with classified summary. 3500 w. R R Gaz—June 24, 1898. No. 21173.

Car Loading.

A Machine for Loading Box Cars. Gives a description and drawing of an ingenious machine for loading crushed phosphate rock into box cars. 600 w. Eng News—June 16, 1898. No. 20877.

India.

Some Features of Indian Railways. J. W. Parry. Showing many interesting features of railway operation and construction in India, and the conditions which have led to commercial success. 4000 w. Engineering Magazine—July 1898. No. 21232 B.

Organization.

Organization of a Railway Engineering Department. Willard Beahan. The writer's views on a better organization of the engineering department of railroads with a view to saving money for the owners of the stock and bonds of the roads. 5300 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21124 D.

The Organization of a Railway. J. H. Goodyear. Discussing the operating department of American railways, and how it may be improved, 2000 w. Ry Age—June 17, 1898. No. 20927.

Punctuality.

Punctuality of the Black Diamond Express. Report of this train for the 12 months ending Dec. 31, 1897. 400 w. R R Gaz—June 17, 1898. No. 20891.

Railway Unpunctuality. Editorial discussion of some of the important points in connection with the habitual lack of punctuallty on the British railways. 4000 w. Engng—May 20, 1898. No. 20582 A.

Repairs.

Is It Desirable to Instruct Trainmen in the

Details of Car Construction and Repairs? J. H. Goodyear. Thinks an improvement in service would certainly follow the instruction of trainmen to some extent in these details. 1300 w. Ry Mas Mech—June, 1898. No. 20733.

Signals.

The Signal System at Glandorf Station. (Die Sicherungsaulage der Station Glandorf.) A full description of this electric block signal system on the Austrian State Railways, with scheme diagrams showing the connection system. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—June 3, 1898. No. 21055 B.

Train Services.

The May Train Sevices. Charles Rous-Marten. A criticism of the summer service timetables in England. 1300 w. Engr, Lond—May 20, 1898. No. 20576 A.

FINANCIAL.

Earnings.

Railway Earnings Continue Large. Record for May, 1898, and for the first five months of the year of the roads of the United States. 2000 w. Bradstreet's. June 11, 1898. No. 20781.

France.

The Railways of France. (Chemins de Fer Français,) A review of the financial workings of the French railways during 1897, with comments on the rates and character of the business. 2000 w. Moniteur Industriel—May 21, 1898. No. 21060 G.

LEGAL MATTERS.

Interstate Commerce.

The Sphere of the Interstate Commerce Commission. Discussing whether the Commission fulfills the ends for which it was created, and if not, what is needed to make it do so. 3500 w. Ry Age—June 3, 1898. No. 20730.

MOTIVE POWER AND EQUIPMENT.

Air Brake.

The Chapsal Brake and Improvements in Railway Brakes. (Le Frein Chapsal, et les Perfectionnements des Freins de Chemins der Fer.) A discussion of the relative merits of the Chapsal and the Westinghouse brakes, maintaining the superiority of the electro-pneumatic system of Chapsal. 5000 w. La Revue Technique—May 10, 1898. No. 21011 D.

The "Standard" Air Brake for Street Cars. A description of the several parts, with illustrations, considering the driving mechanism, the pump, the governor, the operating valve, and the platform equipment. 1400 w. RR Gaz—June 3, 1898. No. 20636.

Box Cars.

Standard 60,000 Pounds Capacity Box Cars—Lake Shore and Michigan Southern Railway. Engravings showing construction, with description. 1500 w. RR Gaz—June 10, 1898. No. 20792.

Car Springs.

Development of the Car Spring. Angus Sinclair, in *The Pall Mall Magazine*. A short account of the first real improvement made in springs, and the added comfort secured. 600 w. Loc Engng—June, 1898. No. 20691 C.

Car Ventilator.

Passenger Car Ventilation. Granville P. Conn. Considers what constitutes a vitiated atmosphere, and the points especially to be studied in car ventilation. 2000 w. RR Car Jour—June, 1898. No. 20788.

Cleaning.

Car Cleaning. F. T. Slack. A statement of methods employed and materials used. Discussion. 9500 w. N. Y. R.R. Club—May 19, 1898. No. 21151 D.

Coal Cars.

80,000-Lb. Coal Cars. Illinois Central R. R. Illustrated description giving dimensions. 1000 w. Eng News—June 16, 1898. No. 20873.

New 60,000-Pound Coal Cars—Lake Shore and Michigan Southern Railway. Illustrates a design for special service in the coal and ore trade from Lake Erie ports and for use with the McMyler unloading machine. 900 w. Am Eng & RR Jour—June, 1898. No. 20603 C.

Couplers.

The Breaking in Two of Freight Trains. Mentions the causes of the parting of trains, and offers suggestions tending to reduce the dangers, if they do not entirely prevent. 1300 w. Am Eng & RR Jour—June, 1898. No. 20608 C.

Crank Pins.

A Comparison of Fiber Stresses in Crank Pins and Axles. L. R. Pomeroy. Gives a table showing the material, dimensions and fiber-stress on pins and axles taken from modern engines, with comments. 700 w. RR Gaz—June 17. 1898. No. 20889.

Draft Gear.

The Westinghouse Friction Draft Gear. Describes the buffer as now made, and notes other improvements, describing the action of the apparatus in buffing and its release, and its performance as a draft gear, reporting experiments of a satisfactory nature. Ill. 2000 w. RR Gaz—June 10, 1898. No. 20796.

Driving Wheels.

Cast Steel Driving Wheel Centers. Illustrations and descriptions of changes in design, reproduced from working drawings of wheels in regular service. 900 w. Ry & Engng Rev—June 18, 1898. No. 20928.

Headlights.

Electric Headlights for Locomotives. States the advantages of electric headlights, and gives report of a test made on the C. C. C. & St. L. Ry. and describes an apparatus designed by George C. Pyle. Ill. 1400 w. Eng News—June 16, 1898. No. 20876.

Locomotive Design.

General Principles Governing Locomotive Design. H. Wade Hibbard. Considers the general principles concerned in operation and repair, with less important and exterior influences. 4000 w. Sib Jour of Engng—June, 1898. No. 20676 C.

Locomotive Design—The Working Stress of

Materials. Francis J. Cole. A study of driving axles, considering their size and the stresses. 2800 w. Am Eng & R R Jour—June, 1898. No. 20609 C.

Locomotive Statistics.

The Ton Mile and Engine Mile in Locomotive Statistics. W. H. Marshall. Showing that changed conditions have destroyed the value of engine-mile records, and made them misleading when employed as a basis for calculating the cost of engine service, and discussing items entering into locomotive expenses. 3000 w. Am Eng & R R Jour—June, 1898. No. 20611 C.

Locomotives.

Baldwin Two Cylinder Compound Locomotives—Norfolk and Western Railway. Describes heavy two cylinder compound consolidation locomotives, having interesting features. Drawings. 1500 w. Am Eng & R R Jour—June, 1898. No. 20602 C.

Competitive Tests of Locomotives. M. N. F. Discusses the methods of testing, or the conditions under which tests are made, and claims that a test which is not competitive proves very little. Suggests that competitive tests be made under the direction of a committee of the Master Mechanics Assn., the object being to ascertain what kind of a locomotive is best adapted for a certain kind of traffic. 3300 w. Am Eng & R R Jour—June, 1898. No. 20607 C.

Compound Express Locomotive for the Northern Railway of France. Illustrates and describes this latest type of the compound express locomotives of this company, which are characterized by exceptional boiler capacity. 1300 w. Engng—June 3, 1898. Serial. 1st part. No. 20834 A.

Locomotive Characteristics. G. R. Henderson. The object of the article is to determine the conditions under which the maximum amount of work or power can be obtained from any given locomotive, of known proportions, regardless of the fuel economy. 1500 w. Am Eng & R R Jour—June, 1898. No. 20606 C.

Locomotive Tenders and Truck Wheels. Editorial discussion of the difference between American and British practice, with the opinions of motive-power men and locomotive builders. 3000 w. Eng News—June 9, 1898. No. 20773.

Passenger Engines—Retrospect and Prospect. George W. Cushing. Reviews the Chicago and and Northwestern system, taking it as an example of western roads. Ill. 1800 w. Ry Mas Mech—June, 1898. No. 20732.

Principal Types of Locomotives in Use in Europe and America. (Principaux Types de Locomotives Actuellement en Usage en Europe et en Amerique.) A list with brief general description of 63 different types of locomotives. 5000 w. 1 plate. Le Génie Civil—May 28, June 4, 1898. Two articles. No. 21006 each D.

Reconstructing Locomotives. Francis R. F. Brown. Notes on the results obtained, showing that the advantages and cost recommend it to careful consideration. 900 w. Am Eng & R R Jour—June, 1898. No. 20612 C.

Simple Ten-Wheel Locomotives with Piston Valves—Wisconsin Central Lines. Illustrates and describes passenger and freight locomotives specially interesting because of the application of piston valves. 1000 w. Am Eng & R R Jour—June, 1898. No. 20604 C.

Spring and Equalizer Action in Locomotives. A. Von Borries. Extracts from an important work, selected and translated by W. W. Nichols. Deals with the influence of equalizers and springs upon the safety of the progress of a locomotive. 1800 w. R R Gaz—June 10, 1898. No. 20797.

Ten-Wheel Passenger Locomotive; Southern Ry. Describes some of the heaviest locomotives built for passenger service, giving some information relating to speed, a comparison of other heavy engines of the same type, and general dimensions. Ill. 500 w. Eng News—June 16, 1898. No. 20878.

The Efficiency of High Steam Pressures for Locomotives. Condensed from the report of a Committee of the American Railway Master Mechanics' Assn. Presented at the Saratoga meeting. 4800 w. Eng News—June 23, 1898. No. 21115.

Wabash Ten-Wheel Freight Engine. Illustrated description of some of the details, with principal dimensions. 600 w. Ry & Engng Rev—May 28, 1898. No. 20563.

Winans' Camel Engines. M. N. Forney. Illustrated description of some old locomotives long used on the Baltimore and Ohio R. R. noting their interesting features. 4500 w. Am Eng & R R Jour—June, 1898. No. 20610 C.

Locomotive Tests.

Locomotive Road Tests — Illinois Central Railroad. Reports investigations made by the students of the Mech. Engng. Dept. of the Univ. of Illinois of the operations of the locomotives of that road. Ill. 2400 w. R R Gaz —June 17, 1898. No. 20893.

Platforms.

Steel Platforms for Passenger Cars. Compares wood and steel platform construction, noting the superiority of the latter in preventing telescoping of cars, and other damages. 800 w. R R Gaz— June 10, 1898. No. 20794.

Pneumatic Press.

Pneumatic Press with Oil Resistance Cylinder—New York, Ontario and Western Railway. Engravings with description of the principal features of a portable pneumatic press used in the shops of the N. Y., O., and W. Ry. 600 w. R R Gaz—June 17, 1898. No. 20888.

Repairs.

Western Prices for Labor vs. Eastern. An important discussion at the Master Car Builders' convention. 5800 w. Ry Age—June 24, 1898. No. 21217.

Reports.

Master Car Builders' Reports. Committee reports presented at the Saratoga meeting—Thermal tests for car wheels, steel car framing, care of journal boxes, springs for freight car

trucks, &c. 5500 w. R R Gaz—June 17, 1898. No. 20892.

Master Mechanics Reports. Gives reports presented at the Saratoga meeting of the association. 13500 w. R R Gaz—June 24, 1898. No. 21172.

Steel Cars.

100,000-Lbs Steel Car. N. Y. C., & H. R. R. R. Illustrated description. 700 w. Ry & Eng Rev—June 11, 1898. No. 20851.

Tenders.

American Tenders for the Imperial Government Railways of Japan. Illustrates and describes a novel style of six-wheel tender to be used with eight-wheel passenger locomotives. 700 w. Eng News—June 9, 1898. No. 20770.

Train.

The Pioneer Limited. Illustrated description of fine cars placed in service on the C. M. & St. P. R. R. 2200 w. Ry & Eng Rev—June 11, 1898. No. 20849.

Wheels.

Balancing of Car Wheels. J. E. Simons. Is of the opinion that cast-iron wheels should be balanced before being placed in service. 1000 w. R R Car Jour—June, 1898. No. 20790.

Car Wheels—Mileage and Thermal Tests. T. A. Griffin. A general average computation of the life of freight car wheels, and a statement of the conditions that have affected the results, with conclusions on thermal tests. 6000 w. Ry Age—June 10, 1898. No. 20799.

Chilled Cast Iron Wheels. E. W. Grieves. A discussion of defects in wheels, and the question of replacing wheels which have failed. Ill. 1200 w. R R Car Jour—June, 1898. No. 20791.

Thermal Tests for Car Wheels. S. P. Bush. Abstract of a paper presented at the Saratoga, N. Y., convention of the Master Car Builders' Assn. A presentation of facts relating to these tests, showing that there is no reason to believe that in obtaining greater safety, durability is sacrificed. 1500 w. Eng News—June 23, 1898. No. 21114.

NEW PROJECTS.

Brussels.

The Metropolitan Railway of Brussels. (Le Métropolitain de Bruxelles.) A discussion of the proposed tunnel and depressed local railway now under consideration for the city of Brussels. 2000 w. Moniteur Industriel—June 11, 1898. No. 21062 G.

Burma.

The Development of Railways in Burma. An account of the methods of working, which, owing to the inferior qualities of labor, are altogether different from the usual practice. The construction and progress are also considered. 2800 w. Engng—June 3, 1898. No. 20829 A.

China.

Notes on the Proposed Siberian-Chinese Railway to China and Korea. (Mittheilungen über der Geplanten Ausban der Sibirisch-Ostchinesischen Eisenbahn nach Korea und China.) With map showing the projected lines, the portion now under construction, and the connections with various steamship lines. 1000 w. Glaser's Annalen—May 15, 1898. No. 21063 D.

Railway Enterprises in China. Translations from Chinese journals in reference to railroad construction. 1300 w. Cons Repts, No. 148—June 23, 1898. No. 21150 D.

Railway Projects on the South-Western Frontier of China. Reports concerning concessions secured by Sir Claude Macdonald, the situation in relation to the French, and the projects completed, in course of construction, and proposed. Map. 3000 w. Engr, Lond—May 20, 1898. No. 20575 A.

Improvements.

The Doubling of the North-Western Railway of India, between Karachi and Kotri. Explains reasons for this change by the increase of traffic, and also the construction of a line including a bridge, advocated by reason of the liability of the road to inundation. 5800 w. Ind & East Engr—May, 1898. Serial. 1st part. No. 20846 D.

Jungfrau.

The Jungfrau Railway. (Die Jungfraubahn.) A general description of the mountain road now in course of construction with views of the present state of the work at various points. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—May 27, 1898. No. 21052 B.

Light Railways.

Light Railways. Editorial on the schemes promoted in Great Britain since the Light Railways Act came in force, giving some of the conditions stipulated, and tabulated lists of railways, approved, and applied for. 2500 w. Engng—June 17, 1898. No. 21182 A.

Narrow Gauge.

Light Railways. Describes the Barsi Light Railway and the Darjeeling-Himalayan Railway. 4000 w. Ind Engng—May 21, 1898. Serial. 1st part. No. 21168 D.

Siberian Railroad.

The Trans-Siberian Railroad. Details from the report of the Imperial Commission to the Tsar on the progress made during the five years ending with 1897. 4800 w. Engr, Lond—June 3, 1898. No. 20823 A.

South America.

South American Railways. Details with respect to Argentina railways, with brief notice of other lines. 1700 w. Engng—May 27, 1898. No. 20710 A.

PERMANENT WAY, BUILDING AND FIXTURES.

Crossings.

A Short Method for Railroad Crossing Computations. L. K. Vial, and R. B. Ketchum. Gives in detail a solution used by the Ajax Forge Co., Chicago, and by the Western Indiana Railway Co., with a discussion of the approximation involved, and a brief comparison

with other methods. 1500 w. Technograph, No. 12—1897-8. No. 20917 D.

Mono-Rail.

The Portable Mono-Rail Transport System. C. C. Hoyer Millar. Read before the Inst. of Min. & Met., London. Gives a general description of the system and considers its advantages. 1100 w. Col Guard—June 10, 1898. No. 20964 A.

Philippines.

Railroading in the Philippines. J. T. M. A description of the railway from Manila before Admiral Dewey arrived. 2000 w. Ry Age—May 27, 1898. No. 20557.

Pole Railway.

A Pole Railway. Details of a novel road in Nova Scotia for conveying lumber. Ill. 500 w. Can Engr—June, 1898. No. 20784.

Rack Railway.

The Development of the Abt Rack Railway System in Austro-Hungary during the past 10 years. (Die Entwickelung des Zahnrad systemes Abt während der Letzten 10 Jahre in Oesterreich-Ungarn.) Roman Abt. A general review of the progress of the Abt systems since 1888 with illustrations of many types of locomotives and details of construction and operation of roads. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—May 13, 20, 1898. Two articles. No. 21050 each B.

Rails.

Laying New Steel. E. A. Haskell. Gives a description of the method of work in track laying on the Boston & Albany Railroad. 2800 w. R R Gaz—June 3, 1898. No. 20637.

Shops.

The Horwich Locomotive Works of the Lancashire & Yorkshire Railway, England. William Forsyth. General plan and brief description of the principal departments of these English shops, which are the largest locomotive repair shops in the world. 1500 w. Am Eng & R R Jour—June, 1898. No. 20605 C.

Rail.

An Old Edge Rail, from the Eastern Railway of Massachusetts and New Hampshire. Illustrates and describes an interesting relic of railway history. 700 w. Eng News—June 16, 1898. No. 20874.

Signals.

Electric Automatic Signals—The Right to Use the Overlap. Gives a synopsis of the decision in the suit of the Union Switch Signal Co. against the Philadelphia and Reading R. R. 2200 w. R R Gaz—June 17, 1898. No. 20887.

Electric Warning Signals for Unguarded Railway Crossings. (Elektrische Warnungslääntewerke für Unbewachte Bahnüberwege.) L. Kohlfürst. Describing and illustrating several systems for giving an audible warning signal at grade crossings when a train is approaching; avoiding the necessity for an attendant. 2500 w. Elektrotech Zeitschr—My 12, 1898. No. 21075 B.

Steel Rails.

Steel Permanent Way. Richard Price-Williams. Read before the Iron & Steel Inst., England. Shows that iron rails could not endure the enormous increase in traffic and tractive power on heavily worked lines, and discusses what has been accomplished in the way of improving and strengthening the permanent way reducing cost, &c., and what needs yet to be remedied. 3800 w. Engng—June 3, 1898. No. 20835 A.

Timber Structures.

Notes on Inspection of Timber Structures. Justin Burns. Suggestions to bridge inspectors in the maintenance department of railroads. 2500 w. Trans of Assn of Civ Engs of Cornell Univ—1898. No. 21125 D.

Tanks.

Self-Feeding Railroad Tanks. Julien A. Hall. Gives some important points in connection with gravity water supply, and shows the advantages of this system. 1400 w. Ry & Eng Rev—June 11, 1898. No. 20850.

Track Joints.

The Relation of Wave Motion in Track to Track Joints. George Tatnall. Discusses the requisites for a good track joint, shows the fallacy of the idea that the ties are fixed and solid supports, giving experiments confirming the facts, and other features of the designing of track joints. 3000 w. R R Gaz—June 17, 1898. No. 20894.

Track Layer.

Machine for Laying Railway Track. (Maschine zum Verlegen von Gleisen.) The Behrends apparatus is intended for handling sections of track and steel sleepers, and consists of a cantilever crane carried on a special steam motor car which hauls the construction train. 1800w. 2 plates. Zeitschr d Ver Deutscher Ing—May 21, 1898. No. 21038 D.

TRAFFIC.

Agreement.

The Southwestern Bureau. The essential articles of the agreement entered by eleven roads, and a statement of its purpose. 1400 w. Ry Age—May 20, 1898. No. 20319.

Rates.

Causes Affecting Railway Rates and Fares. W. E. Weyl. A comparison showing the decline in passenger fares to have been much slower than in freight rates, with a study of the causes, and the peculiar conditions that have caused the discrepancy in the United States. 9000 w. An Am Acad — May, 1898. No. 20306 H.

The Lone Star Case. Gives a history of the trouble which caused a demoralization of rates between New York and Texas, with a statement of the case and opinion of the court. 1800 w. R R Gaz—June 17, 1898. No. 20890.

Traffic.

The Southwestern Passenger Agreement. An account of the organization of this bureau, with the essential parts of the agreement. 3000 w. Ry Age—June 3, 1898. No. 20731.

STREET AND ELECTRIC TRAMWAYS.

Baltimore, Md.

Electric Street Railways in Baltimore, Md. C. B. Fairchild. Notes on the interesting features of the two systems controlling most of the street-railway mileage, considering the power stations, repair shop practice, rolling stock, discipline, &c. 3000 w. Elec Eng, N. Y.—May 26, 1898. No. 20529.

Car Design.

Electric Tramway Car Design. W. E. Partridge. Shows that each type must be adapted to its special work, and gives various designs illustrating the text. 2200 w. Ry Wld—June 2, 1898. No. 20987 A.

Electric Traction.

Electric Traction on Important Lines and the Locomotive. Extracts from paper by Maurice Demoulin. Considers the advantages and disadvantages as compared with steam. 2800 w. Ind & East Engr—May, 1898. No. 20844 D.

Electrolysis.

Electrolysis of Gas and Water Mains. Report of W. A. Chamen, Glasgow electrical engineer. Describes the system of banding, and gives his opinion that there will be no trouble with the electrolysis of gas and water mains as long as the limit is not exceeded. 1200 w. Jour Gas Lgt—June 7, 1898. No. 20886 A.

Gas Trams.

Gas Tramways. (Gasbahnen.) Hubert Nachtsheim. A very complete and fully illustrated description of the Lührig gas-motor tramway system as installed at Dessau, with discussion. 7500 w. 1 plate. Mitt d Ver f d Förd d Local-u Strassenbahnwesens—May, 1898. No. 21091 E.

London Motors.

Specifications for Motors Used on the Central Underground Railway of London. Letter from E. D. Priest of the Gen. Elec. Co. sent in response to a request for further details of these electric locomotives. 900 w. Eng News—June 16, 1898. No. 20875.

Locomotive.

Electric Locomotive for the London Central Underground Railway. Gives the revised plans of the locomotives to be used on this railway. Ill. 800 w. Eng News—June 9, 1898. No. 20772.

Los Angeles, Cal.

The System and Methods of the Los Angeles Railway Company. Brief remarks on the rapid growth of the city, and the development of the street railway system, with illustrated detailed description of the present well-equipped electric system. 3800 w. St Ry Jour—June, 1898. No. 20590 D.

Modern Plants.

Modern Electric Railway Plants. Brief illustrated descriptions of the plants of the Union Traction Company of Philadelphia, and of the South Side Elevated Railroad of Chicago. 2600 w. Engr, N. Y.—June 1, 1898. No. 20640.

Power Cost.

The Cost of Mechanical Traction on Tramways. (Sur le Prix d'Exploitation de Traction Mécanique Appliquée aux Tramways.) A general examination of the items of cost of operation of the fireless locomotive system, based upon data obtained from actual experience. 2000 w. La Revue Technique—May 10, 1898. No. 21014 D.

Project.

The Waunsee Railway Project. (Das Kübler-Schimpff'scher Waunseebahn-Projekt). A description of the scheme of Kübler and Schimpff for an electric road from Berlin to the Wansee with details of the plant. 1800 w. Elecktrotech Zeitschr—June 2, 1898. No. 21084 B.

Rails.

Continuous Rails. Richard McCulloch. Illustrates and describes methods which have been used in the United States, with information concerning the kind of rails used. 3200 w. Ry Wld—June 2, 1898. No. 20986 A.

Rapid Transit.

Power Consumption in Rapid Transit Service. A. H. Armstrong. Describes in detail the plotting of curves showing the relation between speed-time and distance-time, curves showing maximum speeds reached, the relative amount of energy required for the different rates of acceleration, &c. 3000 w. St Ry Jour—June, 1898. No. 20591 D.

Society.

The International Permanent Street-Railway Society. (Internationaler Permanenter Strassenbahn-Verein.) An account of the general convention in Geneva, with a condensed abstract of the subjects and discussions. 3000 w. Glaser's Annalen—May 15, 1898. No. 21064 D.

Tramway.

Kidderminster and Stourport Electric Tramway. Full illustrated description of an English interurban line and its equipment. 3500 w. Ry Wld—June 2, 1898. No. 20985 A.

Kidderminster and Stourport Electric Tramway. Illustrated detailed description of a British line. 1400 w. Elect'n, Lond—May 20, 1898. No. 20571 A.

The British Electric Traction Company. Abstract of address of Emil Gareke, at the staff dinner of the company. Gives an outline of the work accomplished and in prospect, with many interesting matters relating to tramways. 3500 w. Ry Wld—June 2, 1898. No. 20989 A.

Underground Railways.

Metropolitan Railways. Editorial discussing the difficulties to be overcome in using electricity as the power in the London underground railway. 1400 w. Engr, Lond—May 27, 1898. No. 20707 A.

Underground.

Waterloo and City Railway. A description of this interesting English line, with illustrations of the equipment. Map. 2000 w. Ry Wld—June 2, 1898. No. 20988 A.

BOOKS OF THE MONTH

THE HEAT EFFICIENCY OF STEAM BOILERS: LAND, MARINE, AND LOCOMOTIVE. With tests and experiments on different types, heating values of fuels, analyses of gases, evaporation, and suggestions for testing boilers. By Bryan Donkin, M. Inst. C. E., &c. &c. London: Charles Griffin & Company, Limited. 1898.

The subject of testing steam machinery is now being discussed with more than usual energy, and hence the appearance of a work upon the subject of boilers trials from the pen of an expert like Mr. Bryan Donkin is especially timely. So many of the reported trials are contained in special reports, transactions of societies, and private records, that even a trustworthy collection of reliable tests would be welcome, but when to such a collection is added the results of Mr. Donkin's own experience, together with discussions on air supply, heat transmission, stoking, smoke prevention, etc., it will be seen how valuable the book must become to engineer and steam user alike.

As the author says: "Very large sums of money, representing many millions sterling, have been invested in steam boilers, and thousands of engineers are studying economy in coal. The question of heat efficiency is, therefore, not a small one. To generate steam a very large amount of fuel is consumed every year, and much is wasted. If ten or fifteen per cent. could be economized, a very moderate estimate, it would represent a great gain to the world at large. The total annual production of coal in all countries a few years ago was 400 millions of tons. We shall not be far wrong in estimating that one-half, or 200 million tons, is used yearly for generating steam. Putting the cost per ton at the low average of price of 10 shillings, we get 100 million pounds sterling as about the annual value of the fuel consumed under stationary, semi-portable locomotive and marine boilers."

It is to assist in the use of methods of testing, the object of which is the saving of as much as possible of the fuel wasted, that the book before us is intended to serve, and it is admirably adapted to accomplish this end.

After a brief introductory descriptive chapter, the main portion of the work appears in the collection of tables of tests, giving in clearly tabulated form the results of 425 experiments on English and foreign boilers, with details of the boilers, computations of the efficiencies, temperature and analyses of gases, thermal values of fuels and the full results of the tests, with the authorities, localities, dates, and all necessary explanatory remarks. In nearly every test, therefore, the experimenter can turn to this collection, with the reasonable assurance that he will find something closely corresponding to the work he may have in hand and thus be provided with most useful comparative data.

Among the interesting chapters which follow the tables we may especially note that on the transmission of heat through boiler plates, as it contains a valuable compilation of the tests of Blechynden, Durston, Hirsch, Witz, and Kirk, on the much discussed subject.

The general conclusion which is drawn from all these investigations is that "to obtain a maximum efficiency of transmission the cross section of the gas passages should be made small, and thus as high a speed obtained as practicable. The fire-box surfaces should be kept within such limits that the transmission per square foot is the same as that of the gases entering the tubes, and a good circulation of water is essential."

Other important chapters are those on smoke prevention, superheaters, and instruments, while the concluding list of various types of boilers is both interesting and useful.

The book is very fully illustrated and handsomely printed.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.

Harrison Safety Boiler Works, Philadelphia, Pa., U. S. A.=Illustrated catalogue of Cochrane separators, or appliances for removing liquids or solids from steam or other vaporous or gaseous currents. The construction and action of the apparatus are very fully shown.

The King Bridge Co., Cleveland, Ohio, U. S. A.=Catalogue of iron and steel bridges, viaducts, turntables, girders, buildings, eye bars, and structural work of all kinds; with many illustrations of completed structures built by the company.

The Phosphor-Bronze Smelting Company, Limited, Philadelphia, Pa., U. S. A.=Revised price list No. 13, with tables of gauges, sizes, weights and prices of various phosphor-bronze products, together with discount sheet. Also circular of Delta Metal.

The John M. Rogers Boat, Gauge, and Drill Works, Gloucester City, New Jersey, U. S. A.= Catalogue of measuring instruments of precision after Richard's system; also adjustable blade shell reamers, rose chucking reamers, rock drills, and special tools and machinery.

J. H. Williams & Co., Brooklyn, New York.= Illustrated catalogues (*a*) of miscellaneous drop forgings in iron, steel, copper, bronze, and aluminum; (*b*) of bicycle drop forgings, including lists of all drop forged parts; (*c*) of drop forged golf club heads of mild steel; (*d*) description of bathing system in the company's works; (*e*) description of the fire department of the establishment, and the system of fire protection.

Boston Belting Company, Boston, Mass., U. S. A.=Pamphlet showing the trade marks used on the various products of the company, by means of which they may be identified.

The Ball Bearing Co., Boston, Mass., U. S. A. =Catalogues of "Hub" ball and roller bearings, illustrating various forms of thrust bearings, steps, hub roller bearings, and anti friction axles, together with prices, code words, testimonials, and a list of users.

Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A.=Graphite as a lubricant; giving data and results of scientific tests, also opinions of mechanical experts as to the value of graphite, both as a lubricant and as an accessory for engineers and machinists.

The International Correspondence Schools, Scranton, Pa., U. S. A.="What Correspondence Instruction Is." A pamphlet describing the methods of instruction used by the correspondence school, with especial reference to the nature and value of the special instruction books provided.

The Bucyrus Company, South Milwaukee, Wis., U. S. A.—Illustrated catalogues, Part 2, Small Dipper Dredges, of capacity from ½ to 1½ yard; Part 3, Large Dipper Dredges, from 2 to 10 yard capacity; Part 4, Elevator Dredges. Very completely illustrated, and showing the capacity of the concern both for large and small work.

The Risdon Iron Works, San Francisco, Cal., U. S. A.=Catalogue No. 15, Gold Dredging Machinery; Catalogue No. 16, Gold Dredging on Feather River, California; with numerous illustrations, showing dredges in operation.

John Tullis & Son, Bridgeton, Glasgow, Scotland.=Illustrated price list a catalogue of leather, cotton and gutta percha belting, with full description of the various designs and of other supplies such as hydraulic rings, belting fasteners, fire brigade hose; also telegraphic code and useful information on belt driving.

Richmond & Chandler, Ltd., Southall St., Manchester, England.=Illustrated catalogue of agricultural implements and machines, including a new steel drill which has an arrangement for instantly stopping the seed when turning the headlands, a full line of implements are described.

The United Flexible Metallic Tubing Co., Ltd., 112 Queen Victoria St., London, E. C.= Illustrated price list of hardened bronze and steel wired flexible tubing, with list of users.

Sam. Denison & Son, Hunslet Foundry, Leeds, England.=Illustrated price list and catalogue of weighing machines and weighbridges; upwards of fifty types are described, including suspended weighers of 100 tons capacity.

The Thames Mining Machinery Co., Ltd., 83 Cannon St., London, E. C.=Illustrated catalogue of the Jelman-Wepp mining machinery, crushers, cyanide plants, compressers, rock drills, stamps, batteries, etc.

Bruce & Still, Ltd., Norfolk St., Liverpool, England.=Illustrated price list of galvanized corrugated iron buildings and churches.

The Britannia Co., Colchester, England.= Large illustrated catalogue of a great variety of machine tools and engineers' hand tools; also of wood working machinery, twist drills, etc.

Chas. Burrell & Sons, Ltd., St. Nicholas Works, Thetford, England.=(*a*) Illustrated catalogue of patent road locomotives, traction engines, road rollers, ploughs and other agricultural machinery; (*b*) list of testimonials from users of traction engines; (*c*) little book entitled "Hints to Purchasers" giving principal points to be looked for in traction engines.

The Metallic Valve Co., 69 Tower Bldgs., Water St., Liverpool, England.=Illustrated catalogue, testimonials and list of users of Kinghorn's metallic pump valves; describes two types, "multiple disc" and "flexible."

Palatine Engineering Co., Ltd., 10 Blackstock St., Liverpool, England.=Illustrated price list of

the "Deacon" waste detecting water meter and Lord Kelvin's water taps and steam valves; also of steam fittings, forges, hand pumps, vices, etc.

The Weldless Steel Tube Company, Icknield Port Road, Birmingham, England.=Price-list of weldless steel tubes for cycle purposes.

Latch & Batchelor, Ltd., Hay Mills, Birmingham, England.=Four page circular with illustrations, sections, description, strength and weight of wire ropes.

S. E. Norris Co., Shadwell, London, E.=Illustrated catalogue and price lists (*a*) of leather belting and belting accessories, leather laces, etc.; (*b*) of strap and harness leather; (*c*) of fire hose, gun metal appliances and leather and canvas fire buckets.

John Shaw Ltd., Soho Street, Sheffield, England.=Price-list of steel wire ropes and mining requisites, pulleys for rope haulage and steel tub wagons.

The Newton Electrical Works, Ltd., Taunton, England.=Well printed and illustrated catalogue of the "Taunton" dynamos and motors, also of electrical haulage plants, switchboards and combined electric lighting plants.

A. and Z. Daw, 11 Queen Victoria St., London, E. C.=Catalogue of the "Daw" rock drill, the "Daw" air compressors, and other quarrying machinery. List of testimonials, telegraphic code and illustrations accompany each specification.

James Coultas, Perseverance Iron Works, Grantham, England.=Price list of agricultural machinery, corn and seed drills, sowing machines and manure distributors.

The J. C. Nicholson Tool Co., Newcastle-upon-Tyne, England.=Illustrated catalogue of machinery divided into six sections describing (1) treadle lathes, (2) screw cutting lathes and drill chucks, (3) drilling machines, (4) planing, shaping and other machine tools, (5) engineers' and shipbuilders' tools and (6 engineers' hand tools. Full descriptions, dimensions, weights, prices, etc.

The Pulsometer Engineering Co., Ltd., Nine Elms Iron Works, London, S W.=(*a*) Illustrated catalogue of the Pulsometer steam pumps, devoted principally to the conditions in which it can be advantageously employed; (*b*) Pamphlet entitled "A chat about a successful invention" giving further particulars of the pulsometer pump.

Barrows & Co., Banbury, Oxfordshire, England.=Catalogue of street water carts, street sweeping machines manure distributors and chain pumps. Fully priced and illustrated.

Colledge & Bridgens, Church Lane, Wolverhampton, England.=Comprehensive price list of locks, door handles and a general line of iron and hardware supplies including safes, pumps, bath tubs, cisterns, etc.

Webb & Sons, Stowmarket, Suffolk, England.=Price list of leather machine belting.

Hildick & Hildick, Walsall Tube Works, Walsall, England.=Price list of wrought iron tubes and fittings.

Thomas Withers & Son, Phœnix Works, West Bromwich, England.=Price list of wrought iron fire and burglar proof safes, doors, etc. Fully illustrated.

Richard Simon, Nottingham, England.=Circular descriptive of grain dryers, refrigerators, automatic weighers, and sack-filling machines.

Billington & Newton, Longport, Staff.,-England.=Circular descriptive of "Cookes" automatic governor stop valve. Illustrated.

S. Corbett & Son, Wellington, Shropshire, England.=Illustrated and descriptive price list of the "Plymouth" grinding mills for agricultural purposes.

Pearson's Automatic Fire Indicator Company, Ltd., 100 St. Martin's Lane, Charing Cross, London.=Small pamphlet describing this indicator, which works on closing an electric circuit.

Woodroffe & Co., Rugeley, England.=Catalogue of steam engines and combined engine and boiler plant; also of shafting, belting, etc.

Lincolne & Co., 67 North Wallace St., Glasgow.=Circulars describing (*a*) "Tilestoneite," a heat-resisting, rain proof covering for roofs, walls, etc.; (*b*) "Dryasdust," non-conducting composition.

The Phosphor Bronze Co., Ltd., 87 Sumner St., Southwark, London.=(*a*) Well-printed catalogue of phosphor bronze, Duro metal, phosphor tin, Bull's metal, plastic metal, silicium bronze, and other alloys, with results of tests, full instructions for use, and testimonials; (*b*) Pocket edition of the same with condensed particulars.

R. G. Ross & Son, Greenhead Engine Works, Glasgow, Scotland.=(*a*) Catalogue of steam hammers and cranes. The steam hammers are Rigby's pattern, the cranes are principally wharf, forge, and foundry patterns. A machine for flanging boiler plates, and a radial steam hammer are also described; (*b*) Circulars describing Ross' patent caulking tools, portable pneumatic drilling machine, patent speed reducing and increasing gear, and Ross patent rock drills.

T. S. McInnes & Co., Ltd., 41 Clyde Place, Glasgow, Scotland.=Price list of steam indicators, gauges, engine counters, calorimeters, etc., with directions for using, illustrations and testimonials. 24 pp. 5½×9 inches.

McArthur & Jackson, Glasgow, Scotland.=Pamphlet entitled "Lubrication and Lubricating Oils," giving information on colour, smell, specific gravity, fluidity, flash point, and gumming of oils.

John Davis & Sons, All Saints' Works, Derby, England.=(*a*) Catalogue of surveying, engineering, mathematical and meteorological instruments and miners safety lamps, with illustrations, prices and other particulars; (*b*) Circular price list of electric blasting apparatus; (*c*) Illustrated description of the Jeffrey electric long wall coal cutter.